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THE AMERICAN GAS LIGHT JOURNAL

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The Public Lighting Tables of the American Meter Company will be found in the page advertisement of that Company.

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An Asterisk (*) denotes an illustrated article.

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[OFFICIAL NOTICE.]

Twenty-Second Annual Meeting, American Gas Light Association.

AMERICAN GAS LIGHT ASSOCIATION,
OFFICE OF SECRETARY, PROVIDENCE, R. I., Sept. 8, 1894.

Extract from the Constitution.

Sec. 12. Application for Active Membership, or for Associate Membership, or for transfer from Associate to Active Membership, must be received by the Secretary at least 10 days prior to the meeting at which the application is acted on.

GENERAL ANNOUNCEMENT.

The 22d annual meeting of the American Gas Light Association will be held at Washington, D. C., October 17, 18 and 19, 1894.

The meeting will be called to order by the President, W. H. Pearson, of Toronto, Canada, at 10 o'clock, A.M., on October 17, in Builders' Exchange Hall, on 13th street, between G and H streets. This is 3½ blocks from the headquarters, the Arlington Hotel, which is located on the corner of H street and Vermont avenue, one block from the White House. The Arlington is conveniently reached by the principal street car lines, as are the other first-class hotels in its vicinity.

As the most satisfactory quarters are always obtained by writing in advance to the hotel people, the following list of hotels is appended, and it is particularly suggested that in writing to them a reply be requested, and that a self-addressed and stamped envelope should be inclosed, as misunderstandings and disappointments may thereby be averted. Remember, "First come, first served."

Hotel	Rate per Day.	Distance from Hall.	Remarks.
Arlington.....	$4 to $5	3½ blocks.	This is headquarters.
Riggs House....	$3 to $5	2 "	Located at 15th and G streets.
Willard's	$3.50 to $4.50	3½ "	Located at 14th street and Penn ave.
Ebbitt House...	$4	2½ "	Located at 14th and F streets.
Wormley's.....	$3	2½ "	Located at 15th and H streets.
Normandie.....	1 in room, $4.50 2 " 3.50 3 " 3.00	4 "	Located at 15th and I streets. Can take 100 persons.
Shoreham.....	$4	2½ "	Located at 15th and H streets. Can take 125 to 150.
Hamilton House	$2.50 up	4 "	Located at 14th and K streets.
National.....	$4	10 "	Located at Penna. av. and 6th st. Cars go within 3 blocks of hall.
Metropolitan....	$2.50	10 "	Penna. ave., close to National Hotel.
Howard House.	$2.50	10 "	Penna. ave., close to National Hotel.

All of the above hotels are conducted on the American plan, and can take from 25 to 50, except the Normandie and Shoreham (see "Remarks," above). The rates named by the Arlington, Riggs, Willard's and Normandie are special for this convention.

Reduced rates for transportation are being arranged for and undoubtedly will be secured. The final arrangements will be fully explained in a later circular of detailed information.

The roll call will be made by means of the door card method as usual, and be in charge of one of the Committee of Arrangements. Each member or visitor upon entering the hall for the first time will at the door receive a special card upon which to write his name, address, etc., the card then to be given to the doorkeeper.

The list of papers to be read at the meeting is not given herewith, as some of them are still in question, or titles not definitely settled; but the members are particularly requested to carefully read every page of the July and October "Quarterly," and come to the meeting prepared to discuss the articles therein presented, as the papers will be distributed in that form only. A complete list of the papers will be given later in the circular of detailed information.

Each member is expected to send in not only papers on original subjects, but also written discussions or analyses of any or all of the papers written by others, such written discussions to appear in the next issue of the "Quarterly."

The Question Box will be be made a special department of the "Quarterly," provided the members will support it by sending in responses to queries, as well as to keep the Box full of questions, which will be printed in each issue with the responses to the queries of the previous issue. Send in your questions as early as possible; *now*, if you can.

The Committee of Arrangements are completing the details of their programme, which will be reported later in another circular above referred to. The Secretary, however, is allowed to hint that the members will not be obliged to "kill time" for want of entertainment. The ladies will also be well cared for as usual.

Agreeably to the ancient custom of the Association, it is proposed to hold the traditional banquet on the evening of Thursday, Oct. 18, and in continuation of the precedent established last year, each one will pay for his own ticket. In order that the Committee may have some reliable data upon which to base their arrangements, will you please *immediately* fill out and mail the inclosed card to the Secretary, as this is very important, that the data therein asked for should be in his hands

as soon as possible, *whether you expect to attend the meeting or not.* The Committee cannot complete their work without it.

During the days of the meeting bulletin boards will be placed in the lobbies of the Headquarters and the Meeting Hall. All members are warned to take due notice thereof and govern themselves accordingly, that they may be apprised of any change in or addition to the programme.

Many of the members have allowed their dues to remain yet unpaid, and this is a source of much difficulty to the Treasurer and extra work and worriment to the Secretary, who has already sent several statements to each of the delinquent ones, as you must know, if you are one of them, unless you have failed to notify him of change of address.

The present addresses of the following-named members are unknown to the Secretary, who will be glad to receive any information concerning them: Joseph L. Hallett, E. H. B. Twining, Ed. R. Conant, Robert N. Sumner, W. I Wilson.

Don't forget that postal card to return. A. B. SLATER, Jr., Sec.

Extract from the Constitution.

51. No member who owes two years' dues shall be entitled to vote, or to participate in the deliberations of the Association, or to receive a copy of the Proceedings.

52. Any member whose dues shall remain unpaid for a term of three years may be dropped from the roll of membership by a vote of the Council.

BRIEFLY TOLD.

THE BEGINNING OF THE END IN THE BROOKLYN GAS WAR.—Last week we had occasion to remark that an agreement had been about reached by which all antagonisms between the Beckton Construction Company (of which corporation Mr. J. E. Addicks, of Boston, was the ruling spirit) and the Fulton Municipal Company (Messrs. Jordan and Rogers are the controllers of the policy of the latter) respecting their joint influence on the gas supply of Brooklyn were set at rest. Advices dated September 5th confirm the statement, and as these were obtained from the columns of the Brooklyn *Daily Eagle*—subsequent investigation of the same on our own account all points to the fact that the *Eagle* spoke with authority—we reprint herewith the substance of what that publication said: "On August 24th, Mr. Addicks wrote to Mr. H. H. Rogers * * * as Chairman of the Beckton Construction Company, and in substance * * * accepted the terms which had been offered for settlement of all differences, and specified them as follows: That the Beckton Construction Company, in consideration of the sum of $785,000, should turn over to the interests represented by Mr. Rogers one-half of the gas stocks owned by it, as follows: 20,017 shares of Brooklyn stock, par value of $25; 3,094 shares of Citizens' stock, par value $100; 2,185 shares of Metropolitan stock, par value of $100; 375 shares of Fulton-Municipal stock, par value $100; 63 shares Nassau stock, par value of $25; 124 shares of Williamsburgh stock, par value $50, and 125 shares People's stock, par value of $10. All the stock of the Beckton Company and of Rogers' interest is to be placed in escrow in some trust company or companies, where it is not to be disturbed for 12 months, except upon the agreement of all parties concerned, but either interest will be permitted to use the stock as collateral to borrow money to subscribe to a syndicate which is to be formed for the purpose of trying to consolidate all the gas companies of the city. In the syndicate the Rogers interest is to have the privilege of subscribing for 75 per cent. of the stock, while the Beckton Company may subscribe for 25 per cent. of it. If it is necessary to make some other allotments, both shall stand it equally until the share that the Beckton Company has is only 20 per cent., and then whatever other allotments are to be made must be borne by the Rogers interest. Messrs. John C. Moore (of Moore & Schley) and Herman H. Campbell (of Clark, Ward & Co.) are the trustees of the securities. Mr. Rogers is to name one other trustee, and the three are to choose a fourth. * * * On Saturday, a check was paid to the Beckton Company and the stocks were transferred. Mr. Addicks has turned over to Mr. Rogers his resignation as President of the Brooklyn Gas Company, and also the resignation of the Vice-President, Mr. C. W. Blodget." The *Eagle* points out the fact that the price originally paid for the securities held by the Beckton Company was $2,800,000, and, at the price paid by the Rogers interest ($785,000) for 50 per cent. of these holdings, remarks that the transaction means a loss of $615,000 for the Becktonites. On the face of it, such a statement holds good, but the *Eagle* forgets to mention certain concessions made by the Rogers interest (which has been operating the Brookline Company, of Boston, Mass., in opposition to the Bay State Company, of the same city, which is under the complete domination of the Addicks interest) to the Addicks interest of Boston, the nature of which concessions rather goes to show that Mr. Addicks and his party at least stand even, when the dickering is resolved into dollars and cents. Under the arrangement so far, the Williamsburgh and Nassau Companies are normally independent and defiant, but if one looks closely into the agreement above stated, it will be noted that "if it is necessary to make other allotments" in the shares of the syndicate that is to try "to consolidate all the gas companies" of Brooklyn, both the Rogers and the Addicks interests are willing to allow "others" (presumably the independent companies) to come in. On the whole, it looks that Brooklyn is to have consolidation at last, and in that event the most idiotic gas war that ever was projected will have been brought to a termination; and even then only closed at the tremendous price of putting the gas rate in the cities of Brooklyn and New York on the permanent basis of $1 per 1,000 cubic feet. For we again repeat that the Legislature of New York which will rule in 1895 will certainly establish a minimum rate of $1 per 1,000 in "cities having a population of 800,000 or over."

[Prepared for the JOURNAL.]

Some Experiences with a Gas Works in a Cold Climate.

By MR. J. P. GILL.

In the days of "Auld lang syne," when the business of gas lighting was less complicated than it is at the present time, when "Clegg" was the standard of reference, when it was the honorable ambition of the superintendent to make as much and as efficient gas as he could out of a ton of coal, and when water gas was in its infancy, and there was nothing to divert the attention from the regular course of current events, a gas works was built in a town where the temperature would fall at times as low as 45° below zero. Of course, at that degree of cold the mercury in the thermometer would be frozen, and a spirit thermometer would have to be brought into requisition in order to determine how cold it was. The superintendent in charge of the work had previously no experience in so cold a climate, his knowledge being limited to Boston, and intermediate places between there and Petersburg and Norfolk, Va.

A tank was constructed for a gasholder, 60 feet in diameter, with columns and girders of cast iron, of a height for two sections of 20 feet each. The holder was located on a high bank of a river, into which all the drainage from the works was freely emptied. The grade of the company's lot was the general grade of the lower part of the town. Only the upper section of the holder was built and used that season, the lower section being left to be constructed at a subsequent date.

The tank was brickwork laid in cement and surrounded with puddled clay 2 feet wide, well worked and rammed. Being carefully constructed in that manner, it was found to be perfectly water-tight, as had been the case in several preceding instances, the rains supplying the loss by evaporation of the water. Everything now went on swimmingly, or until the mercury had fallen nearly out of sight, when one morning on going down to the works the Superintendent found that the water in the tank was from 4 to 5 feet below the customary level. The earth around the tank had been frozen exceedingly hard, and had broken the bond and raised that mass of brickwork, with the effect that the water was no longer visible, except when looking directly down upon it. This loss of 5 feet, leaving only 15 feet available height of holder, was a serious matter. The inquiry very naturally arose in the mind of the one in charge, how long would he be able to keep the town properly lighted; and the conclusion being unfavorable, he proceeded without delay to carry out the line of action he had determined upon, notwithstanding the cold weather, which fortunately ere long began to show a more reasonable temper. A prompt and cheerful resolution can as a rule overcome apparently insurmountable difficulties.

An excavation was made round the tank, the damaged brickwork removed and replaced with fresh work. The puddling was leveled off about six inches below where the break occurred, but sloping gradually to a point nearest the river. Good, clear, round gravel from about 2½ to 4 inches in diameter was then procured and filled in the excavation, and the tank was refilled with water. Things were now restored to their normal condition and there was never any further trouble in that direction. One thing more remained to be done—to make a provision for the drainage of the gravel. This was necessary, for a heavy fall of rain, or melting snow, with the condensed steam used in keeping the water in the tank from freezing, would soon have filled the spaces between the gravel, and the whole work and expense would have to be again encountered. A well was built about 12 feet or so from the tank and near the edge of the river bank, and a 4-inch pipe was laid to it from the gravel and turned down inside to about 8 inches from the bottom. Another pipe was run to the river, starting about a foot above the bottom of that in the well, thus making a trap which would effectually cut off all communication between the exterior cold and the bottom of the gravel, no matter what might happen between the well and the river. After that there was no occasion for anyone to lie awake at night thinking what prank the frost might play about the works.

A case occurred on the street showing what power the cold has in such a climate. The street mains were originally laid with a covering of 4½ feet of earth, that being thought to be amply sufficient for protection. One day a leak was discovered and on digging down the covering over the pipe was found to be 6 feet, the street having been graded up after the street mains were laid. Notwithstanding this depth, the pipe was imbedded in frozen ground, which could not have been less than 7 feet deep. Search was not continued for the purpose of ascertaining how much deeper the frost had descended. The contraction of the pipe by cold was doubtless the cause of the break. It is no easy and no economical task to excavate earth under such circumstances If a man digs a cubic foot in eight or ten hours, until he gets through

the upper crust, he is thought to have done a fair days work, particularly if he has not handled a pick for several weeks.

Another case occurred which illustrates the value of snow as a protection against frost. A six-inch pipe had been laid in the rear yard of a large manufacturing corporation, partly under grass and partly under a gravelled walk. When the walk was cleared after snow storms, the snow was thrown on the grass until it reached the height of six feet. A break took place one day and it was traced to or near a point under the six feet of snow. On digging to the ground the grass was found to be green and flourishing. It was a sudden transference from mid-winter to mid-summer. There was no difficulty in searching for and finding the leak under such favorable conditions. This break was occasioned by the sinking of made ground.

Another interesting circumstance which frequently occurred was the manner in which the service pipes were affected. As long as steady cold continued, or so long as the weather continued to grow colder, frost in the pipes would not as a general rule be formed; but as soon as the weather became warmer and the ground began to soften, the vapor passing through the pipes would be formed into a kind of hoar frost which effectually prevented the passage of the gas. This took place so rapidly that it was surprising to a novice until he had become accustomed to the phenomenon. The cause was easily accounted for. It is well known that when frozen ground, ice or snow, begins to thaw, it abstracts heat from surrounding objects. The service pipes being as a general thing in contact with the frozen earth, they would lose their warmth as soon as the ground began to thaw, and the vapor would freeze. This illustrates the making of ice cream, the cream being frozen by the melting of the surrounding ice. It also shows why mild weather continues late in the fall and cold weather in the spring. When the earth in the more northerly latitudes begins to freeze in the autumn, it gives out its heat, which keeps a more southerly climate warm; but when in the spring the frozen ice or ground in the more northerly climate begins to thaw, it abstracts heat from places south of it, which makes the spring backward.

The town was a growing one, and it was not long before the consumption in the evenings became considerably larger than the contents of the section of the holder then in use. It was, therefore, necessary to fill the holder to its full capacity before the usual lighting up time and then drive the benches with as full charges as they could carry, in order to keep the holder from touching bottom before the consumers' lights began to diminish in number. One season's experience with this kind of work was sufficient; besides not being safe and for the good of the company, it was a constant source of trouble of spirit. It therefore became important that the lower section should be built when the spring was sufficiently advanced. It would not have been good policy for the company to deprive the citizens of the use of the gas while the work of extension was in progress, and it was decided that 14 feet of clear height should be left in which the upper section might rise and fall, thus permitting the manufacture and distribution of the gas to be maintained.

It was apparently impossible to find anyone who would take the responsibility of executing the work under such conditions. At last a party was reached who was willing to make and erect the section if the engineer in charge would furnish drawings and assume all of the responsibility. This he was very willing to do, and, returning home, he took accurate measurements, made working drawings and enclosed them to the maker, who lived nearly 500 miles distant and had never seen the gas works or the town. A staging was erected around the holder, 14 ft. high, on which the coming section was to be built. The iron work was received in due course of time and with it the men to put it together, which was done on the staging already prepared for it. When the section was finished a rigger was obtained from the nearest seaport, who came with his men and tackling to lower it into the tank. When safely suspended by the ropes, the scaffolding was removed, and the section was lowered, which was accomplished with ease and safety.

When resting on the bottom of the tank it was found to fit the upper section with exact nicety—as well as if the two sections had been united together. The success of the work and the working of the holder were entirely satisfactory, and nothing better could have been desired. While the work was being done the consumers were supplied with all the gas they required. When the holder was completed a house was built over it to protect it from the high winds, intense cold and heavy snows which often prevailed in that locality, and matters were again in a relieved and secure state.

Before long, however, another state of affairs arose which, while requiring action, was by no means unacceptable. The retort benches were originally built of 3's and could furnish about 80,000 cubic feet of gas per day. The capacity of the holder was 120,000 cubic feet. An increase of manufacture of at least 50,000 cubic feet was called for in order to meet the increasing consumption. It was not deemed advisable to extend the works by enlarging the retort house and increasing the number of benches, and there was no time to spare to take down the benches of 3's and rebuild; so it was concluded to build in a *downward* direction (this course, it will be noted, is not recommended as a proper one to be pursued in all business transactions), and that the arches should not be disturbed. The tops of the old ash-pans being about four inches above the door sills, an excavation was made deep enough to put in two additional retorts, and then the side and rear walls were undermined by successive steps. The brick-work built up under them and the retorts reset. The old walls and arches had not perceptibly settled. No one would ever have thought, from the continued good working of the benches, that they had not been erected for five retorts when the works were built.

Perhaps other subscribers may be willing to contribute similar experiences for the entertainment of the many readers of the JOURNAL.

[Concluded from page 333.]

Photometry.

[The third and last of a series of lectures delivered before the British Society of Arts, by Capt. W. de W. Abney, F.R.S.]

The sensitiveness of the eye to changes in intensity, I have shown you, varies according to the intensity of light from which the variation takes place. As my time is short, I must omit some other theoretical considerations which it was my intention to show you. I will first of all commence by showing you how it can be ascertained whether a light is up to the standard temperature, such standard temperature being required for visual and photographic comparisons.

It is well known that by mixing two properly chosen spectrum colors white light can be formed, and when I say white light, I mean the color of the light under trial. Now, for lecture purposes, it is useless for me to try and use the light of a candle to form a spectrum. It would be invisible to you all; but I can use the electric light just as well for the object I have in view, viz., the demonstration of the principles involved. Now the whiter the light, the more blue and violet there is in its spectrum. There is, therefore, a large quantity of blue and violet in the electric light. I will form a spectrum, and place a slit in the orange and another slit in the blue, so that I can have a slice of each colored light. By means of a lens I can cause these two slices of spectrum colors to expand and overlap and form an image of the face of one of the prisms used, and I can then cause a beam of the original light to illuminate a white surface alongside of it. The two slits can now be opened till they form by their mixture exactly the same color as the original beam. Let us see if we use another source of light whether we shall get exactly the same result, keeping the slits as they are. I tone down the electric light by a very pale yellow glass; the light imitates very closely gas light. If we place it in front of the slit of the spectroscope, so that the spectrum is the spectrum of the yellower light, and the incident beam is the yellow light, you will see at once that the mixture of the two colors no longer gives the same color as the yellow light. Making the light the same as the amylacetate lamp light, you will see again that the balance is upset, the two patches of light on the two white surfaces are no longer the same.

Here, then, we have an indication of the method to pursue in ascertaining if lights are of the same quality. By having two adjustable slits in the spectrum, which will with a standard light exactly match the color of such a standard, we can at once see if any other light is of the same value; if it is not, the two illuminated surfaces will be of a different hue. Another plan is to use proper colored glasses in front of a lens, and allow light to pass through them in such proportions that they cast an image of a beam of exactly the same color as that of the standard light itself. When another light is used, equality of color no longer exists.

There is one method of altering the intensity of a light, if it be a glow-lamp which may interest some. In the first lecture I showed how the visible rays increase in intensity in a parabolic curve. This was further investigated by General Festing and myself. If each ray goes up parabolically, it is probable that the sum of them does the same. In a paper read at the Royal Society on December 8, 1887, we showed that our surmise was correct, and that if a constant was deducted from the current multiplied by the volts, the result was the squre root of the light multiplied by a constant—($w - m = n \sqrt{y}$,) which is a parabolic. By altering the resistance in the lamp, and reading an amperemeter and a

voltmeter, the result is obtained, though it is sufficient if the amperes alone be read, for then $c^2 - s = t\sqrt{y}$, very nearly when c is current and y the light, s and t being constants.

As to the use of the sectors, it has been brought to my notice that Mr. Ferry has called in question the accuracy of the sectors when comparing lights of different colors with one another, such as lime light and a glow-lamp. He states that for light of the same color, and for monochromatic light, no error can be found in its use. I may refer, however, in opposition to this, to some experiments which were carried out by General Festing and myself, in which the luminosity of the spec-

Fig. 1.—Back View.

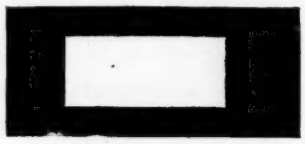

Fig. 2.—Front View.

trum was measured without the intervention of the sectors, comparison having been made with a glow-lamp. It was found, as published, that the two methods gave identical results. There are many other experiments which show that no error in the results obtained with the sector have been found by us. That this is the case, we may take to be the fact by direct and indirect measures.

There is, in my opinion, no method so good in photometry as that of using properly moving rotating sectors, whose open apertures can be altered at will. It allows both lights to remain stationary, as, also, the screen. This method of diminishing the intensity of the light was, I believe, first introduced by Fox Talbot more than fifty years ago, though he had not the advantage of using movable apertures. This principle of altering the aperture during rotation I first saw exhibited by Mr. Kempe, Q.C., at a *soirée* of the Royal Society. It was applied to color top. Without entering into the history of the matter, however, let me show you the exactitude with which such sectors can be employed.

In doing this, I wish to introduce to your notice a photometric method which I brought out, and is, I believe, very fairly successful. I am not saying it is the very best for comparing ordinary lights, but it fills a gap for measuring light transmitted through bodies, which is very convenient. The principle of the screen, you will at once see, is different from almost any other. It consists of a square aperture cut in a thin disc, and over this is stretched a white piece of paper of such a nature that the light from an illuminant is only scattered, and no direct image can be seen under any circumstances. On the other side is cut a mark in black paper or black retint, which is exactly double the size of the cut-out square, and this is filled up by the white paper stretched over the aperture, so that we have a rectangle of paper half of which is translucent and the other half opaque. If now we place a light behind the aperture, the half is illuminated by transmitted light, and if a light is placed on the other side, the whole rectangle is illuminated. By placing a rod in the path of this last beam, we may cast a shadow which prevents the last illuminating the half through which the transmitted beam comes, and then we have half the paper rectangle illuminated by transmitted light, and the other half by incident light. If the paper be of good quality, the light will appear of the same color. By placing the rotating sectors in the path of the front beam and altering the apertures, we may cause the two to appear of equal brightness.

Now suppose I want to examine the amount of light transmitted through this piece of ground glass, I can readily do it. If I place it near the candle, and use an ordinary Bunsen or Rumford photometer, I shall find that it varies according as I place it close to the source of light, or half way, or close to the screen. It is quite evident that the closer I place it to the screen, the truer will be the measure of the total amount of light transmitted. With this photometer I can get the ground glass close to the screen, and we then get a measure of the transmission of light through it. An objection has been made that light has been reflected back from the surface of the white paper to the glass, and back from that surface again. This may be true to a very limited extent. If I take a piece of ordinary glass, and hold it close to the lamp, I can balance the two lights, bringing it closer and closer, till it in fact almost touches the aperture, you will see that the balance is undisturbed. A variety of experiments has shown that any error caused by this is negligible. We can take a piece of a photographic negative and test it in the same way, and balance it, and move it at different distances towards the screen; we find that if we strike a balance when it is near the light, it becomes apparently darker as it approaches the light, then gets lighter and lighter, till it appears lightest of all as it approaches the screen.

Another point is this, that it need not be used in a totally dark room, where provision is made that any light there is must pass through the body under measurement; a small amount of diffused light is of no very great moment anywhere, since it illuminates the front of the rectangle, and has no effect on the measures of the light transmitted. We can also use it for colored objects, such as colored glass. For ordinary purposes it suffices if the glass be placed against the aperature, or in the path of the beam somewhere, so long as the aperture is only illuminated by the light transmitted through the glass. This makes one-half colored; but it is easy to balance the illuminations by the oscillations of the sector. [This was experimentally demonstrated.] The light passed through is then very easily found. Again I may use colored paper and do the same. To myself it is more easy to balance a colored light against a white one than a white one against the white. I need scarcely say that, first of all, the illuminations of the white surfaces are balanced, and the sector opening read before the light coming through any colored or other body is measured. If the white surface require a sector opening of 80°, and only 40° when a body is against the aperture in the screen, half the light is transmitted.

We may often want to know the amount of light reflected from a body, and the next photometer I shall show you is used by me for that purpose. It is very similar in principle to the last. The aperture is cut as before, but instead of being covered up, it is left open to allow the colored object to be placed in it, alongside a white square. Instead of two lights one light may be used for this photometer, a reflection being used instead of the second light. This avoids any alteration in the relative intensities of the two lights used, for they both are from the same source. A rod casts shadows, one on the aperture and the other on the white square. The aperture is fitted with, say, a gray square, and the sectors in the direct beam altered till the two appear of the same color; or I may introduce a colored object and repeat the process. In this case, of course, first of all the aperture should be fitted with a white surface and a measure taken, and the aperture of the two measures of the sectors gives the relative brightness of the two objects.

There are often cases where we may wish to measure bodies which only allow but very little light to pass, though they are transparent. In such a case we have to use a very powerful light, and it may be that the body varies greatly in absorption at different parts. For this reason I use the electric arc light as the source, and concentrate it so as to give a brilliant beam. There are, however, variations in the electric (arc) light from time to time, and unless the comparison light, with which the relative intensities passing through different parts of the wedge are measured, varies at exactly the same time and in the same proportion, the measurements will often be very much out. If we merely wish to measure the white light transmitted, the apparatus to employ is not very extensive, and Fig. 3 will show what it is. $E\,L$ is the electric light, placed in a lantern or box of some kind, to prevent the room, which should be slightly darkened, from being flooded with light. L_1 is a condenser which throws an image of the crater of the positive pole upon the slit S of the collimator C. The rays issue parallel, and are caught by a lens L_{III}, which forms an image of the slit upon the surface of the wedge, W, placed in a proper position and in its mountings. The light, after passing through the wedge, forms a circle of

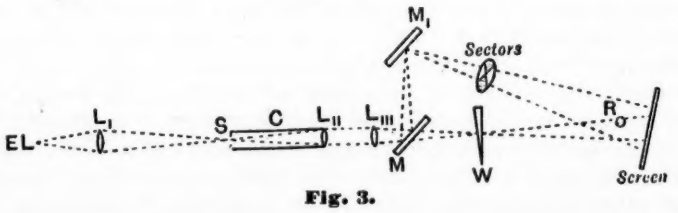

Fig. 3.

light on the screen. It will be noticed that the image of the slit may be as narrow as one wishes by opening or closing S, and that we have a line of light passing through the wedge, such as is required to effect the graduation. Calculation will show that, with a fairly narrow slit, the measured intensity passing through it may be taken as that passing through the mean thickness of that part on which the image falls.

Placed in the path of the beam, and between the wedge and L_{III}, is a plain mirror, M (for which I often substitute a prism of $1\frac{1}{2}°$, and so obtain a single reflection), which reflects the light at right angles, or any convenient angle to its path. It is again reflected from M_1, a silver on glass mirror. An image of the slit is formed in the path, and a second disc is formed on the screen. The center of this disc is made to coincide

with the center of the disc formed by the light passing through the wedge. A rod, *R*, is placed in the path of the two beams, which casts two shadows, one illuminated by one beam and one by the other. The usual black mask is used on the screen, to confine the attention to a small part of the shadows.

It will be seen that, when any variation takes place in the light, it equally affects both the illuminated shadows; hence the measures may be made without fear of error creeping in. Sectors with apertures, moving at will whilst they are rotating, are introduced, as shown in the figure, and sometimes a second set of fixed sectors are introduced between *M* and *W* should the light passing through *W* be too bright. The screen is placed perpendicular to the line bisecting the angle made by the two beams. It should be noted that this plan almost necessitates movable sectors, but sectors which are fixed at known apertures can be used at a pinch, and the balance made by moving the wedge in its settings.

It should be remarked that though the wedge may not be pure black the readings can be very readily made by the method of oscillating between "too light" and "too dark" for the shadow whose brightness is controlled by the sector. In making a valuation of the wedge, the first thing to do is to compare the lights without the intervention of the wedge, and then to take readings.

For certain purposes it is necessary to know how much of each color of the spectrum is transmitted through a wedge, and Fig. 4 shows how this is accomplished.

The electric light and the collimator are placed as before, but the parallel emergent rays fall upon a pair of prisms and the spectrum is brought to a focus by L_{11} on to a screen in which there is a slit against

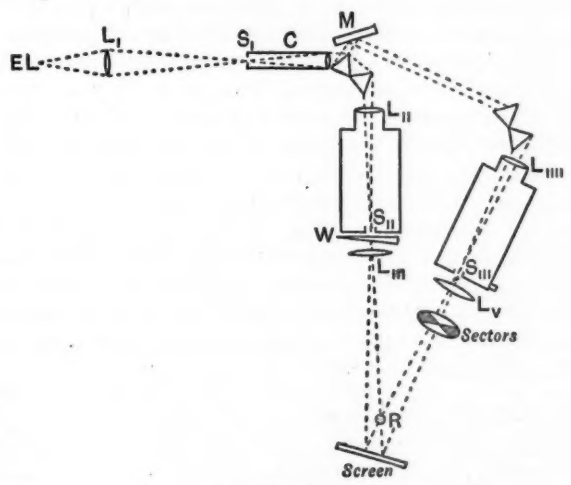

Fig. 4.

which the wedge in its setting is placed. The slit can be placed in any spectrum ray, and the wedge surface is always kept perpendicular to that ray. A lens, L_{111} brings the rays to a focus, so that a monochromatic image of the surface of the last prism is formed on the screen. From the surface of the first prism parallel rays are reflected; these are caught by a mirror and fall on a pair of precisely similar prisms, and the remainder of the apparatus is exactly the same as that described above, a second patch of colored light being formed over the first patch. The slit, S_{111}, is so adjusted in the spectrum that the two patches are of the same color. The sectors are placed as shown in the figure, the rod, *R*, forming two shadows as before. The method of procedure is to place the slit, S_{11}, in some color in the spectrum, and S_{111} in the same. The wedge is then graduated for this beam throughout its length, another position is taken up, and the same process gone through. By this means we get the logarithmic factor of transparency for each part of the wedge for the whole of the spectrum colors.

The last point that I shall have to refer to is an apparent failure of the law of inverse squares as regards photometry.

I have upon the screen two patches of spectrum light—a red and a green—of equal intensity; if anything, the red is rather the brighter. I place the rotating sectors in front of them and gradually close them. Notice that the red begins to fade away much more rapidly than the green. When very nearly closed the red has disappeared and the green remains not of its light green color, but as a green-gray.

Let us argue from this what should result. If when we illuminate a screen with red light we can remove it to such a distance that the screen becomes invisible, though if we have green light, which appeared of equal brightness when close to it, we should be able to remove it much further before the same screen became invisible. The point at which the screen disappeared from view would evidently be the zero point from which the illumination would have to be reckoned for the color which was used. So with white light, there is a point at which the screen would become invisible. Evidently, then, the law of inverse squares for illumination appears to fail for low intenseness of light, and this is owing to the insensitiveness of the eye. Theoretically, of course, the screen may be moved to an infinite distance and still be visible. The law is obeyed practically, of course. It may be thought that this limit of vision is of no practical account; but I must say that it is. For instance, in the photographic room we use red light, and we find that the corners of a fairly-sized room are invisible. If we use canary medium the corners will be well illuminated. This is owing to what I may call the superior space penetrating power of illumination of the yellow-greenish light over the red.

I have not been able to show all I wished owing to want of time, but I trust that what I have shown may not be lacking in instructiveness.

Natural Gas in Indiana During 1893.

The following is the full text of the report of Mr. Jordan, Inspector of Natural Gas for the State of Indiana, for the past year:

While natural gas has been prospected for by the drilling of wells in nearly every county in the State of Indiana, yet outside of the areas mapped out and published with former reports from this department, no developments have been made of any scientific or commercial importance. The boundaries of the "belt," as it is called, have been clearly defined. No discoveries have been made that make necessary any change. Vast sums of money have been expended in this State in prospecting for natural gas, without any returns. Much of this could have been saved if the prospectors had understood the conditions necessary for the production of gas.

The perpetuation of the natural gas fields is a question of vital interest to Indiana, as this State has been benefited to the extent of millions of dollars within the last few years by the discovery of this valuable fuel.

The History of Gas.—The history of the natural gas fields shows that they are of only temporary duration. Indeed, it is only natural that the accumulations of centuries should be exhausted in time by the constant and immense drains to which all the fields have been subjected. Nature cannot manufacture it as fast as it is consumed, and the natural flow of the wells must soon become exhausted. Gas in the great fields of Pennsylvania and Ohio is a thing of the past, if the natural flow of the wells is to be relied upon for the supply. Affairs are in a distressing condition in those States, and especially in Northwestern Ohio, as all the towns are left burdened with debt and with no other resources at their command. Their era of prosperity is at an end, so far as it depended upon natural gas. In many of these towns, as a natural result of the criminal waste of nature's most valuable fuel and the unnatural business excitement and wild speculation that obtained for years, it may be truthfully said "that their last days shall be worse than their first." It remains to be seen whether the same disastrous conditions will mark the end of natural gas in Indiana. About the time that natural gas began to fail in Ohio and Pennsylvania, the great fields of Indiana were discovered, and their vast extent, as well as the apparent stability of the supply of the wells seemed to warrant the belief that at last a permanent supply had been found. As a result of this discovery and the failure of the Ohio fields, the factories accepted the offer of the cities and towns in the Indiana gas field and removed their plants to this State. The loss of these factories to Northwestern Ohio caused a terrible panic and collapse throughout that gas belt, and fortunes sank from sight as values declined to their normal conditions. Over $300,000,000 has been invested in this State in manufactories, and others are now being erected throughout the gas belt. Pipe lines were run to the gas field from Chicago and from many of the principal cities and towns in the State and every effort has been made to gobble up as much of the territory as possible. Slowly the ends of these pipe lines have been converging to a given point, until now but little of the gas belt remains to be developed. There is no question but the time will eventually come, although a long way off as yet on account of the vast extent of the fields, when every inch of Indiana gas territory will have been developed, and then the supply will rapidly diminish.

The Failure Has Begun.—Indeed the failure has already begun. Already wells are being abandoned every month, and the rock pressure in many parts of the field is rapidly diminishing. The average field pressure has slowly but surely fallen off, and now stands reduced from 320 pounds, original pressure, to 240 pounds, average pressure over the field. To preserve a full supply of fuel gas to their patrons the different

companies and the manufacturers have been obliged every year to reach out to remoter fields, drilling many new wells and extending great pipe line plants at very heavy cost.

The limit of extension is nearly reached. Many wells are wet; nearly all show moisture when heavily drawn upon, and they must be held back or risk the danger of being flooded out.

At the rate of pressure reduction that is now going on, and by a continuance of the present extravagant and wasteful method of consumption, it is only a question of a very short time when artificial pressure will have to be used to force the gas through the pipe lines. The use of pumps for artificial pressure is fraught with most serious risk of reducing the gas pressure below the water pressure, and so destroying the wells. The question of perpetuating or husbanding the supply of the field becomes a vital one. Indiana has the largest and best gas field ever discovered, and as no new fields are in prospect it seems that these are the best fields that will ever be brought into requisition for manufacturing purposes.

With these gloomy conditions of the supply staring us in the face, we should awake to a realization of the fact that natural gas is a temporary blessing. It is the plain duty of every good citizen to co-operate to the fullest extent to preserve the supply of gas so long as it is possible to do so. It is the plain duty of managers of companies, or those engaged in furnishing supplies of this fuel, to sound the note of alarm and to point out the way by which the flow of gas can be prolonged, and this great source of comfort and convenience continued over the longest possible period. A system of the strictest economy should be enforced, and the remainder of the precious gas should be distributed to the consumers as ordered by special acts of the Legislature.

An Era of Prosperity.—Immediately upon the discovery of natural gas in Indiana an era of prosperity began that has been unparalleled. Immense manufacturing establishments were located, and in time, when their fires, fed by nature's best fuel, started, great train loads of their products were sent out from the gas belt every day. Villages became prosperous towns, and towns grew in a few months into thriving cities, and lots were sold at high prices many miles from their centers.

Much wild speculation has prevailed. A great deal of unnatural and unhealthy excitement in business has marked the history of some of these towns since the discovery of this fuel. However, this has not been carried to the extent that it was in the towns of Ohio. The business men of these towns, profiting by the fate of the towns in the States above mentioned, have been more conservative. One of the worst features of the excitement that has prevailed was the belief in the ideas that natural gas was to be perpetual.

This belief fostered extravagance and waste. It can be shown from facts obtained and reported in this department that the waste of gas during the first four years after its discovery in the fields of Indiana amounted to more than $20,000,000. And this estimate, too, is made upon the extremely low prices at which gas has been sold throughout the State.

This condition of affairs continued, as I say, for four years before the people who were virtually interested were willing to admit the fact that natural gas was failing, and failing rapidly, too. The pressure began to go down in all the principal centers, and, in fact, nearly all over the field.

The supply in many places began to fall short, and there was much suffering during the hard winter of 1892–93. A great many factories in the towns deriving their supplies from this gas field were shut off from the lines and asked to burn coal.

Alarmed by the Great Waste.—These stern conditions have at last aroused the people to view the situation in its true light. Much of the extravagance and waste has been stopped. Men are seeking to find out the best means for husbanding what remains of this valuable fuel. Some wholesome laws were passed by the Legislature for the preservation of this fuel. In regard to these laws, I regret to say that in some localities they have not been enforced as rigidly as they should be, and the fault has been with the local officers charged with enforcing the laws. Many of these officers are aspirants and are afraid of their popularity.

One of the wastes of gas that still prevails is in the domestic consumption. With the appliances for burning gas that are almost universally used at least 50 per cent. more gas is used than is necessary to produce the required amount of heat.

The greater the pressure in a mixer, the greater number of cubic feet of gas is consumed with only a fixed amount of air. Natural gas, like any other fuel, requires a certain amount of air in order to have a perfect combustion. It follows, then, that the higher the pressure the greater the amount of gas that passes through the mixer and the more imperfect is the combustion. With the imperfect appliances now in use the greatest amount of heat is not obtained. This is not only wasteful, but it is dangerous from the fact that this half burned gas is liable to escape into houses and cause suffocations or explosions.

With the mixers now in general use a pressure of from 6 to 10 ounces in the low pressure mains will furnish as much, if not more gas than can be perfectly consumed. Under the conditions existing in most, if not all, of the towns and smaller cities of the Indiana gas field pressure of from 1 to 5 pounds is carried.

Improved Mixers and Burners.—Too much cannot be said on this question. All who are interested in the perpetuity of this fuel should be taught to know what extravagance and waste are being practiced and the causes. Consumers have been slow to adopt improved mixers and burners. In many of the towns the gas plants are not arranged for the proper and equal distribution of the gas. Improved appliances and devices cost money, and so long as the present method of paying for the gas by the month or year is permitted, just so long will the present waste continue.

The remedy is to compel, by legislation if necessary, consumers to pay for the gas used by meter measurement. When this method shall become the rule consumers will find it to their interest to adopt improved methods for burning this fuel, and will economize its use in every way possible. Until this is done I can see but little hope for economy in the consumption of this precious fuel. The waste will continue and the end will be correspondingly hastened. The supply of gas is certainly failing. It may not be possible to tell just how long it will last, but the final exhaustion is inevitable. The period of exhaustion has been entered upon in the Indiana field and the end is close at hand. The theory of the generation of this fluid in commercial qualities is not now believed or advocated by any person who has studied the conditions as they exist. Indeed, it is more than probable that this generation ceased many ages ago. There is a given amount stored within the area of the gas bearing rocks. This storehouse is tapped in Indiana by many hundreds of wells, and millions of cubic feet are drawn out every day. As gas is withdrawn water or oil comes in and takes its place. Turn whichever way we may in our explorations and theorizings, the fact of the final exhaustion of this fuel stares us in the face.

The Initial Gas Pressure.—The following is the pressure found in different localities during the year 1893. At many of the places, however, the pressure given was obtained only from new wells at a distance of from two to four miles from the towns, the wells in the towns and immediate vicinity showing far less pressure, and many wells being practically exhausted:

	Pounds.
Greenfield, Hancock county	250
Carthage, Rush county	120
Noblesville, Hamilton county	240
Sheridan, Hamilton county	240
Kokomo, Howard county	250
Marion, Grant county	250
Gas City, Grant county	300
Fairmount, Grant county	300
Elwood, Madison county	300
Frankton, Madison county	300
Anderson, Madison county	240
Alexandria, Madison county	300
Summitville, Madison county	300
Chesterfield, Madison county	290
Muncie, Delaware county	240
Albany, Delaware county	280
Eaton, Delaware county	290
Hartford City, Blackford county	260
Montpelier, Blackford county	250
Camden, Jay county	225
Dunkirk, Jay county	275
Greensburg, Decatur county	175
Fountaintown, Shelby county	210
Waldron, Shelby county	225

These pressures were found in the most instances in new wells. In their immediate neighborhood are found older wells showing a much less pressure, even below 100 pounds.

The wells connected with the pipe lines conveying gas to Indianapolis, Crawfordsville, Frankfort, Lafayette, Logansport, Peru, Wabash, Huntington, Bluffton, Fort Wayne, Decatur, Portland and Shelbyville show pressures from 225 to 260 pounds.

The wells and the pipe lines leading to Chicago and Richmond are better, showing 280 and 290 pounds pressure. These companies, in or-

der to keep up the necessary supply of gas, are compelled to drill many new wells each year to take the place of those that have become exhausted. Each year these companies have been compelled to acquire new leases and extend their lines, until there is but very little territory to be obtained. If, in drilling these new wells, the pressure of the original wells could be obtained, there might be some hope of perpetuity of the gas. But such is not the case. The new wells are coming in with a constantly decreasing pressure, and of a necessity will be much shorter lived than the original wells. All this goes to prove that the field is slowly but surely becoming exhausted. This exhaustion will be in an accelerated ratio as we approach the final end.

The Situation is Grave.—The gravity of the situation can only be understood when it is known that from 225 to 250 pounds pressure at the head of the main lines is absolutely necessary to force the gas to the different cities that lie outside, but are obtaining their fuel from the gas field, with sufficient pressure to distribute it through the low pressure city lines to the consumer. And this pressure, too, is needed when all the reducing stations and district valves are wide open and every facility afforded for free circulation. There remains now but a small average margin above the limit of low pressure. At the annual rate of pressure reduction, and by a continuance of the present extravagant and wasteful method of consumption, this small margin will be spent or exhausted in a very short time. When this shall have happened, artificial pressure by means of pumps will be resorted to for the purpose of distribution. It has been the experience of the gas areas of other States that when the initial pressure must be supplemented by artificial means that the end is very near at hand. A careful study of the conditions of the field in Indiana as they exist to-day will show that we have almost reached that point.

What must we do? Are we willing to go back to the use of wood and coal? After having enjoyed the conveniences and luxuries of natural gas for so long a time, to do so would be a great hardship. In order to avoid doing so, or at least to put off the evil day as long as possible, consumers should be willing to adopt any method that would preserve this fuel and perpetuate its use for the longest possible period of time.

The Remedy for Present Evils.—In order to do this I have the following suggestions:

1. All gas should be sold by meter measurements, and this should be enforced by law.

2. Natural gas should not be used in the manufacture of bricks, tiles, nor in the rolling mills nor melting furnaces of glass factories. In these factories a coarser and less valuable fuel can be used.

The highest and best purpose to which natural gas can be applied is the domestic use. It is in this use that it does the greatest good to the greatest number, and it is for this use that it should be preserved.

Gas Measurement by Meters.—The present consumption in the domestic use of gas, as I have said, is without doubt fully 50 per cent. greater than is actually necessary. This profligate waste of such valuable fuel is inexcusable. Now, if it is possible to check this extravagance, I believe the supply can be made to last several years. There is but one way to stop this reckless and criminal wastefulness, and that is to require each consumer to pay for just what the consumer uses. No more and no less. This can be done only by the use of a meter. Natural gas is a commodity, and a very valuable commodity, and every other commodity in the commercial world is sold by weight or measure. Experience has shown that this is the only just and equitable way of selling natural gas. The price per 1,000 feet should be approximately the same as charged in cities where conditions are similar. The following are the net meter rates per 1,000 feet charged in other cities: Detroit, Lima, Piqua, Dayton, Springfield, Toledo, Buffalo and Columbus, 25 cents; Pittsburgh, Allegheny and Erie, 22½ cents; Jamestown and Corry, 21.6 cents; Fostoria and Logansport, 20 cents; Indianapolis, Richmond and Fort Wayne, when sold to manufacturers by meter, 10 cents.

When the time comes that consumers will be compelled to pay for what they use, then, and not till then, will economy be practiced. Then it will be that the consumer will provide himself with the most improved appliances for the economical use of this fuel. There is a growing disposition to introduce meters into all the distributing systems of the natural gas companies. When this fuel was first brought into use the supply was so abundant that the reckless wastes of which I have spoken were tolerated. When it was taught and generally believed by consumers, that the supply was inexhaustible, the necessity of economy was not felt. When it cost the same by the month or year, whether much or little was consumed, there was no inducement to economize.

Gas Formation has Ceased.—I have before stated that it is held by all scientists and others who have given the matter any thought that gas is not being generated at the present time in any appreciable quantities, and certainly not in quantities sufficient to meet the enormous drain that is being made on the different fields to-day. This being true, the necessity for husbanding the supply in every conceivable way becomes apparent. The highest interest of every consumer is to make the product last as long as possible. Any waste or prodigality in the use of this most valuable fuel becomes at once a crime against the public good. "The greatest good to the greatest number" should be kept in view in the use and management of this fuel.

By prodigality and mismanagement the final failure of this product has been hastened all too rapidly. This failure cannot be overlooked. It is shown by the diminished initial pressure and by the presence of salt water.

An advance in price on the part of all municipal corporations for all the uses they undertake to supply is now the proper policy. The prices at which this fuel has hitherto been furnished has led to the undervaluing and wasting of gas. The supply will do towns more good by serving them longer if they are required to pay a higher price for the gas.

Natural gas is merely a transient phase of the stored power of the earth. It is folly to talk of its taking anything like a permanent place in the work of the world. The claim that it can do so springs only from enthusiasm, and is unsupported by the facts. There is in reality but little of it, and this is found in but limited regions and cannot last long whenever its utilization is undertaken by the eager and masterful activities of our day.

If proper management of the field by the enforcement of wholesome laws, and if economy in the use of gas is everywhere insisted upon and practiced, that portion of gas that yet remains stored in the Trenton limestone of Indiana may be made to last several years. It is to this end that all should work.

To Perpetuate the Fields.—Now that the final exhaustion of the supply of natural gas is an admitted fact, many persons are directing their attention to the finding of a substitute that shall combine all of its luxury and convenience. Plants for the manufacture of fuel gas have been built in many cities, and are in operation with some degree of success. However, none, so far as I have been able to learn, has succeeded in manufacturing a fuel that is equal to natural gas. The inventive genius of the American people is unlimited, and I predict their success in this direction. Natural gas has been a great object lesson to great communities as to the advantage of gaseous fuel, and it can hardly be that this lesson will be given in vain. It has prepared the world for something much better than itself. Natural gas has done a very important work.

In many of the gas fields, as has been before stated, when the gas is exhausted in the porous rock, oil takes its place. A theory has been advanced by some that the gas fields can be perpetuated by forcing air down the wells into the rock by means of powerful pumps. Some of the cities and towns of Northwestern Ohio, I have been informed, are now engaged in very extensive experiments in order to test this theory. The Trenton rock in those fields, being oil-bearing, is porous and saturated with oil deposits. It is thought that by forcing the air through the rock it becomes carbonated, and after being thus filtered returns to the surface of the earth, where it is piped and consumed.

In regard to this theory, the facts at hand are not sufficient to warrant me in hazarding an opinion as to its practicability in the production of fuel. That air can be forced through the porous portions of the Trenton rock is undoubtedly true. Demonstrations of this have been shown in the Indiana field. A high-pressure pipe line passing through low-pressure locality and having low pressure wells connected with it will cause an increase in the well pressure in the immediate territory surrounding such wells. This has been experienced at Noblesville, Hamilton county, and at Kempton, Tipton county. In fact, this condition may be observed on any pipe line that has wells connected therewith whose initial pressure is lower than the line pressure. This fact is so well known that many gas companies disconnect their low-pressure wells that lie in the immediate neighborhood of wells belonging to rival companies. Without doing this, they know that by this means they would be furnishing gas to their rivals without compensation.

In regard to the air becoming sufficiently carbonated in its passage through the oil deposits contained in the pores of the Trenton limestone, to make it a fuel equal to natural gas, I have no means of knowing. I shall await with a great deal of interest the outcome of the experiments that are now being made. In partial support of what is expected to be accomplished by the supporters of this theory, it may be said, first, that within the greater portions of the gas fields of Ohio and Indiana large oil

deposits are found in the porous rock, and second, that the forcing of air through this porous rock by artificial means is practical.

In the putting in of gas plants, or in their extension or improvement, every means should be adopted in order to make them absolutely safe. Human lives, as well as property, are too valuable to be endangered by the insecure handling of this powerful agent, through mistaken and criminal notions of economy.

The Transportation of Gas.—One of the great wastes of natural gas that exists in Indiana gas fields is the leakage from pipe lines. During the early days of the fuel, when most of the pipe lines were laid, experience had not then taught the necessity of using the best pipes and fittings. Cheap pipe and cheap connections were the rule. Especially is this true in what is known as "farmer lines"—that is, lines that supply people who live in the country. These lines, as well as many that supply the towns and cities, were laid by persons of no experience, and were not tested as to their capacity to withstand high pressures. The result was that leaks were at almost every connection in many of these lines. Much improvement, however, has been made in many of these plants. Better material and better work have been substituted. Especially is this true of the plants that have been put in more recently. Good material is now used, and the lines are thoroughly tested before being subjected to the pressure from the gas wells. A fair estimate of the results of these improvements would be that the loss from leakage from the pipe lines has been reduced more than one-half. Not only was there a great loss of valuable fuel from this source, but there was a great danger to life and property. Many accidents have occurred that have resulted in the loss of life and the destruction of much valuable property that can be directly traced to leakage in pipe lines and mains.

All pipes used for the conveyance of natural gas should be tested by hydrostatic pressure up to at least 300 pounds to the square inch, and the pipe should be rapped with a hammer while under pressure.

Cast iron pipe may be generally used for low pressure, but it should not be used for high pressure mains. In conveying gas under a pressure 50 to 250 pounds to the square inch only the best of lap welded wrought iron or steel pipes should be used. And on this kind of pipe, when the threads are cut, the metal should be made thick, so that the pipe should not be reduced in strength at that point. One source of great weakness is in the special fittings. They should all be made of the best malleable iron or steel. Many companies are now having their fittings made to order much heavier than those generally found in the market. Even the best wrought iron and steel pipes should be subjected to a hydrostatic pressure of at least three times as great as any pressure that it will be subjected to in use.

By a special act of the General Assembly of Indiana of 1891 the pressure in high pressure pipe lines is limited to 300 pounds.

Substitutes for Natural Gas.—That the supply of natural gas will last but a little longer is conceded by all persons who have given the matter careful and serious consideration.

That a gaseous fuel from some source will continue to be extensively used is also generally conceded. Natural gas will have prepared the way for the use of gaseous fuel. The failure of natural gas will, doubtless, bring heavy losses to many individuals, firms and corporations. Still it will have accomplished much good in that the knowledge gained by the experience during the years of its existence will greatly benefit the public in general.

The use of a gaseous fuel generated in producer furnaces is now largely used in the operations in metallurgy. The great saving in this method of firing over that of the direct use of coal is probably due in a measure to the utilization of the waste heat in the regenerative chambers. Fuel gas of this character, however, that is made by the admission of air to the incandescent fuel, cannot be carried long distances, except at an expense greater than its value as a heat producer.

In the manufacture of water gas, coke or anthracite coal must be used. No process has been invented yet whereby soft or raw bituminous coal can be used successfully for this purpose. So long as this is true this gas cannot be made cheap enough to come in competition with direct firing with the soft coals of Ohio and Indiana.

It is probable that a mixture of coal gas, water gas and producer gas will be the fuel gas of the future for domestic purposes.

Many people are looking anxiously to some of these fuel gases, or to a combination of them, as their source of fuel when natural gas shall have failed. No doubt before that time arrives the manufacture of these gases will have been brought to such a state of perfection as to cheapen them so as to bring them within the reach of all the uses to which this fuel is applied. The vast sums of money invested in conducting mains will not be lost, as the public in many localities will have become so accustomed to a gaseous fuel that they will never return to the use of solid fuel. Then it will be that the slack and waste at our coal mines will be converted into fuel gas and be conveyed through the mains laid for conveying natural gas to manufacturing places and for domestic use.

Motor-Driven Carriages for Common Roads.

Engineering News says that the recent French competitive test of road carriages operated by motors of various types, is a good illustration of the adage that history frequently repeats itself. When the use of steam was first suggested as a means of propelling vehicles on land, the new motive power was commonly thought of as a possible literal substitute for horses on the common roads of the country. The idea of providing a smoother and firmer roadbed, offering less resistance to traction by laying down lines of rails, came later with the development of the locomotive and with a clearer understanding of the field the locomotive was to occupy.

The idea of a steam road carriage occurred to Watt as long ago as 1769, for in his patent of that date he included the employment of his steam engine for running carriages on land; but he never carried this idea into effect. Some authorities give the Frenchman Cugnot credit for a similar purpose, and in the same year, 1769, he actually built a locomotive with a pair of 13-inch single-acting cylinders, operating a crank that drove a single driving wheel with a roughened periphery. This engine is still preserved in Paris. Hornblower, in England, is also credited with the invention of a steam carriage at about the same time; but the Cornish engineer, James Murdoch, in 1784, certainly did make a road engine, and he tested it with somewhat striking results, according to current story. In his model heat was applied by a lamp, and he modestly saw fit to make his first test on a dark night. He fired up his engine, and when all was in working order, connected the working parts, when it got away from him and started at full speed down the road. The firing, puffing little engine is said to have met the clergyman of the parish in its erratic course, and frightened that worthy gentleman into believing that he had at last actually met that Evil One against whom he hurled weekly invectives from his lofty pulpit. Be that as it may, Murdoch made a road engine, and his crude model is still preserved in England, or was as late as 1850.

In America, Oliver Evans, as early as 1787, obtained a Maryland patent, giving him the exclusive privilege of making "steam wagons for use on roads and railways." And in 1801 he built a floating dredging machine, operated by the first successful double-acting high-pressure engine ever made. By putting wheels under his boat and connecting them with his engine, he propelled this nondescript craft 1½ miles overland to the point of launching.

But these early and clumsy attempts at building steam engines to run upon the common highways failed to materialize into anything of real service, for several reasons. In the first place, these highways were in a notoriously bad condition, as a rule, and the roadbed provided was not adapted to the weights deemed necessary and the lack of power characterizing these earlier machines. Then, too, the managers of the turnpikes took fright and violently opposed what they believed might eventually interfere with the use of horses and their tolls. But probably the most potent cause of arrested development in road carriage construction was the fact that about 1802 Trevithick and Vivian demonstrated the fact that it was possible to run steam engines upon a smooth line of rails, even upon slight gradients, and the attention of inventors was turned in the new direction.

About 1828, however, in the general railway craze then prevailing, the subject of road carriages again came forward somewhat prominently, and a great deal of ingenuity was displayed, for that time, in meeting the supposed demand. In our issues of Sept. 8, 1888, and Dec. 21, 1889, will be found some illustrations of what the good people looked forward to. Steam "buggies" were to supplant horses, and steam stage coaches were really built and run for some time for hire. It is sufficient here to note among these the steam coach of W. H. James and Sir James C. Anderson, of 1829, which carried four to six passengers, and, on its trial trip, from Vauxhall Bridge to the "Swan," in Clapham, ran the 2½ miles in 10 minutes, at a speed equivalent to 15 miles per hour. This coach weighed less than 1 ton, with fuel and water on board.

In 1831 Sir G. Gurney built a steam wagon and ran it between Cheltenham and Gloucester, a distance of 9 miles, and with from 10 to 12 passengers frequently made the trip in 40 minutes. Gurney, later, attached a coach to his motor, and thus carried 33 passengers over the same road in 50 minutes. He ran his coach for four months and carried over 3,000 passengers, and attempted to extend its use throughout

England and Scotland. But the success of the trial at Rainhill and the speedy extension of railways, coupled with the difficulties of adapting his read wagon to the varying condition and gradients of common roads, put a quietus upon further effort in that direction. That the effort to introduce the road carriage, however, was an earnest one while it lasted, is made plain by the number of devices proposed and described in the journals of the day. Among these inventors may be mentioned Julius Griffiths, in 1821, and Messrs. Burstall, Hill, Bramah, Seaward, Dance, Hancock, Ogle and Summers, in England and Scotland, and in America, Harrison Dyar, Joseph Dixon, Rufus Porter and Mr. James, who all attacked the problem with more or less success. Even upon the railways of England to this day, the preservation of at least the outline of the coach body in the railway carriage bears witness to the original thought in the employment of steam for moving land vehicles.

The famous trial of locomotives on the Liverpool and Manchester Railway, in 1829, and the genius of Stephenson, Braithewaite and Ericsson soon demonstrated the fact that to successfully run a locomotive you must first provide a proper roadbed, and from that time until within a very recent period the subject of mechanically propelled carriages for common roads was practically dropped. The railway was steadily developed along with the locomotive, and except for adaptations for agricultural purposes, or for hauling heavy loads about docks, etc., the road engine no longer attracted the attention of inventors. But well within the last decade, and encouraged by the wonderful recent developments in motors, in fuel, and in mechanical science generally, inventors have again taken up the problem so long ago laid aside.

France, with its excellent system of government roads, has taken up the subject in earnest, as the number of machines originally entering for the trial instituted by *Le Petit Journal* testify. According to the reports of this trial, motors operated by petroleum or gasoline used in a gas engine, promise the best results. Though the weight is still considerable as compared with an ordinary carriage, this is not a serious fault, and much mechanical skill and ingenuity have been displayed in designing, stowing and connecting the parts of the motor so as to furnish a compact and neat-looking vehicle. The speed attained is fully sufficient for all practical purposes, and the first cost is by no means excessive, as contrasted with the expense of keeping horses and a coachman. The report does not deal with the subject of the amount of skill and experience necessary to handle a road carriage of the Daimler gasoline type, but this ought not to be great. The most serious fault found, apparently, is with the odor from the gaseous exhaust and the vibration of the carriage when the motor is still running but is disconnected from the driving gear.

Steam comes next to petroleum in point of adaptability, though it is best adapted for hauling heavier loads in omnibus traffic. The Serpollet boiler is a favorite here, with its very heavy section of coil, its vertical form and the small amount of water carried in it at one time. Steam can be raised very quickly with it and a high pressure obtained, and the heavy coil, with a small quantity of water circulating through it, decreases the danger from rupture and reduces this danger to the lowest limit possible, all very important considerations in a motor of this character.

Compressed air and electricity cannot as yet be usefully applied for this purpose, though the attempt has been made. If air is used, it must be compressed to a pressure of 1,000 pounds per square inch or more, and this demands strong and heavy cylinders. And to provide against freezing at the exhaust another cylinder must be carried, charged with heated water, through which to pass the air on its way to the motor, on the Mekarski principle. Weight and power storage capacity are here the difficult problems to solve.

With electricity, the storage battery system seems alone to apply, and here again weight of dead load enters as a potent factor. In the one electric road carriage which entered the French trials the total weight was 1,000 pounds, with 500 pounds of this in the storage batteries alone. Then, too, the jolting of the carriage is liable to flake off the paste used upon the leaden grid, a trouble present even when the carriage runs upon smooth rails. Another difficulty lies in the application of the electric power to the driving axle and the reduction of the high speed of the motor to a speed suitable for driving and to the variation in speed that such a carriage must possess. What the immediate future of the storage battery system may develop in this form of applying power no one can now foretell; but the possibilities are great, and if it could be economically and efficiently applied, electricity is certainly the least objectionable of all forms of power applicable to this use.

The whole subject is practically a new one as it is presented to inventors at the present time, and with the present wonderful advance in mechanical science over the slight knowledge possessed by the inventors of 1830, the achievements and lack of practical success of that day can in no way measure the possibilities of the immediate future.

That there is a vast field open when once the application of mechanical motors to ordinary road vehicles is made practical, requires no proof; and while improved highways will greatly facilitate the solution of the problem, on the other hand the introduction of mechanically propelled vehicles will give a new stimulus to the movement for better highway construction.

Incandescent Gas Lighting.

[A paper read by Mr. R. S. Galloway at the last meeting of the North British Association of Gas Managers.]

The introduction of incandescent gas lighting is due to the distinguished Continental scientist and inventor, Dr. Carl Auer von Welsbach. The Doctor is still a comparatively young man—not over 36 or 37 years of age; but he is old in knowledge. With Dr. Auer's discovery, gas lighting has entered upon a new epoch.

The system of incandescent lighting by means of electricity is familiar to one and all, but incandescent gas lighting requires a little explanation. The ordinary manner of burning gas is both wasteful and inefficient, and many patents have been taken out to utilize a gas flame as a heating instead of a lighting medium; but none have been successful till Dr. Auer's. The point of excellence in his invention is that immediately the gas is lighted the light-giving body, or mantle, is raised to its highest incandescence, and this without any forced pressure or alteration of existing fittings. All other systems which have been tried (and soon abandoned) have necessitated either artificial pressure, or else the incandescence has not been attained for some considerable time.

By his system the gas is supplied through a special form of atmospheric or Bunsen burner, which can be attached to any existing fittings. The flame thus produced is non-illuminant, and combustion practically complete, with a consequent absence of the smoke and dirt which accompanies the use of gas in the ordinary way.

As just mentioned, the flame is non-illuminant, and its object is merely to raise to a high state of incandescence the hood or network—technically called the "mantle"—which is suspended over the flame. This mantle has for its principal ingredient as to its incandescent substance (to use the inventor's own words) "characteristic constituents of certain minerals occurring mostly in the high northern latitudes. In spite," he continues, "of the accurate development of the methods of separation which I discovered in the course of my scientific labors on this subject, they have to change their form many hundred times before they are obtained in the pure state in which alone they can find application on the incandescent material."

The former mantles, as first introduced, were inferior to those now in use, being only supposed to give about 7 to 10-candle power per cubic foot of gas, whereas the present, or "C" mantles, give from 18 to 20-candle power per cubic foot of gas consumed. Moreover, the mantle now gives the light for close upon 1,200 hours, without diminution, while formerly 500 hours was all that could be reckoned on. Some mantles now even last about 3,000 hours, and on being then tested on the photometer, they show an illuminating power greatly in excess of a No. 7 Bray burner. However, 1,200 hours is the time claimed for a mantle to last, which is scarcely equal to two mantles per annum on an average. As to the fragility of the mantle as regards use, there is none, so long as the printed instructions are adhered to.

The advantages of this invention will be at once apparent to you by the following figures; and in placing these before you I must inform you I am dealing with Scotch gas—or, to be more particular—gas made from Scotch coal. By tests made on the photometer, it is found that a No. 7 Bray burner gives 5-candle power per cubic foot of gas used, while an incandescent "C" burner gives from 18 to 20-candle power. Moreover, a No. 7 Bray burns 5 cubic feet per hour, against 2½ cubic feet for an incandescent, and 6 cubic feet for an Argand. That is, an incandescent burner, burning 50 per cent. less gas, gives over three times the light. With these figures it is unnecessary to say the pecuniary saving is great.

Then as to its advantages over electricity. An ordinary incandescent electric lamp gives 16-candle power nominally. Therefore more than three electric lamps would be required to give equal results to one incandescent "C" gas burner. Taking 2,000 hours as the average burning time in a year—*i. e.*, as nearly as possible five hours per day all the year round—the cost of electric current, at 8d. per Board of Trade unit, would amount to over £11; whereas the cost of the "C" incandescent gas burner consuming 2½ cubic feet of gas per hour would be, with gas at 2s. 8d. per 1,000 cubic feet, 13s. 4d. To put this in another

form: For a given sum of money an ordinary 5 feet per hour gas jet will give three times the light, and an incandescent gas burner will give over twelve times the light of an incandescent electric lamp.

Moreover, it must be distinctly understood that when more than 2½ feet of gas is passed through an incandescent burner complete combustion does not take place, and consequently the light is diminished. The same applies to too rich gas—that is to say, as good a light can be got from 15 or 18-candle gas as from 25-candle gas. This, to gas companies, where incandescent lighting is adopted, will help to recompense them for a reduction in their sale of gas.

And now for its hygienic benefits. Suppose a room lighted by one incandescent burner consuming 2½ cubic feet per hour gives a light equal to three burners consuming a total of 15 cubic feet per hour, the atmosphere of the room must be proportionately improved, both as regards heat and purification. Professor Renk, the eminent Berlin expert, who was commissioned by his Government to write a report on the system, goes further than this. He shows that not only is the reduction in heat proportionate to the reduction of gas consumed, but that, the heat being turned into light, the amount of heat generated is still further reduced.

Again, take a piece of porcelain and hold it over the open flame of a Bray or Argand burner. Within a short time you will have a black deposit of carbon on it. Hold it in the flame of a Welsbach lamp, and it remains perfectly white. This of itself is a great advantage, not only from a hygienic point of view, but also to householders and shopkeepers, as, no matter how near the roof incandescent lamps are placed, the ceilings remain quite clean and good, and are not damaged by dirt.

While on the point of hygiene, it may not be amiss to call attention to the superiority of the Welsbach system over any other form of gas lighting as regards the eyesight. In the first place the eyesight is affected by the general condition of the room; and if the atmosphere is vitiated, and the temperature is very high, the effect on the eyesight is injurious. Added to this, the flickering and insufficient light is most injurious to the eyesight. Now, we all know from experience that we can depend on our ordinary supply of gas; and so long as the fittings conducting it to the point of ignition are in good order, a perfectly steady light can be got from the Welsbach burner. If, for reading or writing, the light thus obtained is too brilliant, this is a defect remedied by means of shades, and on which no two of the general public are of the same opinion. It is a known fact that the electric light is injurious to the eyesight; and the incandescent gas light can therefore claim to be not only superior in this respect to other forms of gas lighting, but also to electricity.

And now, having referred to the advantages of this system of lighting, it may be well to disabuse the public mind that this present system of Welsbach incandescent gas lighting, and which has been more prominently brought before you during the past few months, is the same that was introduced some seven years ago. It is the same, and it is not the same. True, the idea is the same—viz., raising a filament to a high temperature, or to incandescence, through the agency of a flame from an atmospheric burner. But every part of the lamp (mantle included), as already stated, has been improved, till now the whole is almost perfection. The burner is now made to cause practically complete combustion; is more ornamental than formerly; and can be fitted with a regulator, which counteracts any variation of pressure.

Another valuable improvement in connection with this is the introduction of the bye-pass or pilot-light burner. This can be supplied either attached to each burner, with separate taps, or to a cluster of burners with a tap at any part of the room or hall. Here it may be remarked that the suspension of the mantle over a central rod, or crutch, removes all liability of the support "giving" with the heat, and thus breaking the chimney and damaging the mantle. The chimneys employed are made of the best glass procurable in Europe, and the breakage of these, which formerly was a cause of annoyance and expense, is now practically obviated. A flaw may be found in any workmanship, no matter how good; and my experience shows only about 1 per cent. of these to be faulty. But should they stand the first lighting, they will, with ordinary usage, last for months. Mica chimneys are now used in some cases, and with these any breakage is impossible.

This light is now, by specially constructed burners and lamps, applied with success to outside lighting. Some towns in England have their streets lit by it. It has been experimented with, and so far successfully, in Glasgow, Edinburgh, Leith and Portobello. On the Continent, Naples, Weisbaden, Munich and Prague, etc., have their streets all lighted by it. It is also in use in every railway station from the Dutch frontier to Berlin.

What has already been said may be summed up as follows: (1) The light is practically one-eighth the cost of electric light. (2) It is from one-tenth to one-fifth the cost of other systems of gas lighting. (3) Its hygienic advantages are not obtainable with any other system of gas lighting. (4) It can easily and readily be attached to existing fittings. (5) It is suitable for all inside and outside lighting.

Lighthouse Illuminants.

Mr. James Kenward, F.S.A., in the course of a paper read by him before the last meeting of the British Association on the above named subject, having recounted some of the earlier types of lighthouse equipment, went on to say: I must, however, say a few words on the extreme forms of apparatus now before the world. The conception of the great gas flames for which Mr. Wigham is distinguished led him naturally to suggest apparatus of such dimensions as would not render the light ex-focal, but would condense it normally. And he further sought to augment the luminous power of his lighthouse by superposing the lenses in the manner first specified by Mr. Brown, of Lewisham, in two, three, or even four tiers, with rings of flame graduated up to 108 jets in the focus of each tier. He used for this purpose Fresnel annular lenses extended to about 70° of vertical angle. The two lights reported in our Admiralty list as the most powerful of all lights in the United Kingdom, other than electric, are constructed on this method. Tory Island has a maximum intensity of 326,500 candles, Bull Rock of 333,500 candles. The Tory apparatus is composed of three superposed tiers of lenses, six in a tier, each lens subtending 65° of vertical and 60° horizontal angle. These 18 lenses are of 1,330 mm. radius, and are arranged as a triple-flashing light, each flash lasting about three seconds. The whole height of the optical glass is 17 feet, the width of each lens about 5 feet. The illuminant is the expanding gas burner referred to. The lenses are of French construction. The Bull Rock apparatus is also hyper-radial, or 1,330 mm., but it is a single-flashing light, arranged in triple tier, with lenses of 75½° verticle angle, or 6 feet 10½ inches high, and 60° horizontal angle. This light is of English construction. The illuminant is a Douglass 8-wick petroleum burner, and it will be noticed that the power of the Tory light is exceeded.

But, still ambitious of higher intensities, Mr. Wigham has experimented with what he truly calls a giant lens, successfully made for him by the eminent constructor, M. Barbier, of Paris. This lens has a focal length of 2,000 mm., a horizontal angle of 90° or 10 feet in width. Four such lenses would form one tier, and it is proposed to have three tiers, with a total height of 22 feet. In the focus of each tier would be placed an expanding gas burner of 148 jets, and the combined intensities are expected to attain a value of from three to five millions of candles in the beam. It is obvious that this gigantic apparatus would require a lantern of dimensions exceeding all hitherto adopted, and that the lantern would demand a tower of corresponding amplitude. The rotation of such masses would also be a difficulty. Superposition of lenses might, of course, in theory, be carried so far as to make the tower itself a luminous column from platform to base, while the magnitude of the lenses and of the gas flames might be increased indefinitely. But the practical limits to such extravagances need no illustration, and it would be easier to appeal to the beacon fires of antiquity, which might be made, if volume is to rule us, to extend across half the sky.

The advocates of volume, especially where gas is in question, have, perhaps, overrated the advantage of producing reflections on the sky which should be visible to the mariner when the lighthouse itself is below his horizon, or of producing glares on the fog around the lighthouse which may indicate its position. The late Dr. Tyndall, whose knowledge of pharology was not the least conspicuous of his many attainments, but whose partizanship in regard to one system led him to the brink of positive injustice towards others, has laid great stress on the value of the thrills or pulsations of light on the opacity of fog. But it would, I conceive, be a highly dangerous thing to induce mariners to trust to this assumed property of gas flame for identification of their position. The fog may be around the vessel and not around the lighthouse, or *vice versa*. The distance and density as regards the observer are never certain. The glare of the flashes in period and in duration is liable to be variously misapprehended. There may be no cloud available for transmitting reflections beyond the lighthouse horizon. Nor, indeed, is gas flame the only illuminant diffusible over fog. Oil flames of equal or lesser magnitude are also capable in this respect, and notably the electric arc.

The reflection from the sky of the Creac'h Point electric light has been observed three hours before it was seen abeam, and Captain W. F. Robertson was able from this reflection to calculate his position.

The Isle of May electric flashes have been seen on the clouds at forty or fifty miles distance. The electric light at Macquarie, Sydney Heads, has been repeatedly recognized, when it was below the horizon, at 70 miles distance. The Tino light at Spezia, also electric, has been seen by Dr. Preller, from Via Reggio, a distance of 23 miles, through a fog of moderate density. Its appearance was then like the blurred disc of the full moon. In densest fog, of course, the only safe rule is to use the lead, to blow the horn, and, where needful, to anchor; but these prudent measures of the old time are discredited in our day of record-breaking passages and of penalties for late arrival.

The arc light represents the opposite problem we have to deal with. It is the champion of the little against the great—the David of electricity who will prevail against the Goliah of gas. Among my early and happy memories of Faraday I include one pertinent to this: "The apparatus for the electric light of the future," said he to me, "will one day be no bigger than my hat." This was almost realized at the first trial at Dungeness, but the power of the early lights was distinctly inadequate. Then a course of larger dioptric apparatus was entered on, the culminating point being reached in the Macquarie, the Isle of May, and the St. Catharine's. These lights had carbons of very unequal diameter, those of Macquarie not exceeding 25 mm., giving an intensity of 12,000 candles, while those of St. Catharine's were 60 mm. and capable of 40,000 candles. The luminous powers varied from 5 to 7 millions of candles. Such intensities would seem potent to vanquish fog, but what the sun cannot do no earthly light can, though it be *para materia* with the sun. And there is always a capricious uncertainty about fog in quality, density and direction so that it can never be predicted of any particular fog and any particular light that one shall penetrate or the other quench.

I have referred to the Macquarie light and to the Tino light. The splendor of the St. Catharine's light in clear or even misty weather is testified beyond all doubt. And yet this light failed utterly, it is said, to keep the "Eider" from grounding in a fog on the Atherfield ledges. Similarly I have failed to get even a glimpse of the May Island light at a distance of only twelve miles with a slight mist around me. And the evidence of a fisherman at the recent inquiry as to the wreck of the "Jasper" was that at a mile distance he could not see the light on May Island. St. Catharine's is often invisible at a quarter of a mile with its 6,000,000-candle power. Yet, notwithstanding these conflicting results of observations of some notable electric lights in thick weather, I am disposed to agree with the conclusion of the Trinity House after the South Foreland experiments in 1884, that the arc has an absolute superiority to oil and gas at all times and seasons.

And there is a new and startling development of arc lights that renders the superiority more certain. Within the past four or five years the excellent administrators and engineers of the French lighthouse service have effected what needs only the sanction of experience to prove an important revolution in lighthouse economy. Invoking the principle of very rapid rotation of the lenses, they may be able to dispense with dioptric apparatus larger than the third order of 500 mm. radius, and are, indeed, adopting lenses of only 250 mm. and 300 mm. radius. For the Isle of Porquerolles a double-flashing light of the third order has lately been constructed by Messrs. Barbier of Paris, who had already made a fourth order for Corsica, and a third order for Iles d'Hyères, both having four lenses, and who must above all be credited with that striking experiment the 4-lens first order apparatus exhibited at Chicago, destined for the Hourtin lighthouse, Gironde. A second order light with two lenses has been constructed by M. Lepaute. All these lights are for oil flames.

The best known example, however, of the *feux-éclairs* is the La Hève electric light at Havre, constructed by the historic house of Sautter, in Paris. The optical glass of this apparatus, placed about 400 feet above the sea, does not exceed four feet in height. It has four sides of 90°, with a total vertical angle, prisms included, of 143°. It is composed of sixteen elements—namely, four of the lens center, twelve of catadioptric prisms. It is bifocal, or with a separate focus for the lenses and the prisms. It gives a flash at intervals of five seconds, thus making a revolution in 20 seconds. The duration of each flash is one-ninth of a second. The carbons used are of about 23 mm. diameter. The value of the beam is estimated at a maximum of 25 millions of candles when the air is clear, the current then being 25 amperes. The abnormal speed of rotation is maintained by means of a pillar and float resting on a bath of mercury, which counterpoises to a large extent the weight of the apparatus and framework, and thus diminishes the friction due to the motion.

It is on this notable acceleration of speed whereby four flashes, lasting in all less than half a second, are obtained, that the power of La Hève light mainly depends. Each flash is sufficient for "integral perception" by an average eye, and the whole luminous energy of an ordinary flash lasting 2, 3, or 4 seconds is condensed into that integral perception of a ninth of a second. It may be interesting to compare with the La Hève the composition and the performance of a small electric light—though it be not so small as the Faraday hat—designed by Messrs. Chance for the Naval Exhibition in 1892. This was placed on the Eddystone tower there—a full-sized model tower—and was intended to represent on a reduced scale the last Eddystone apparatus constructed, also by Chance Brothers, for the Douglass tower of 1881. The real Eddystone is a biform of twelve sides, 920 mm. radius, and 12½ feet high. The Chelsea model is 18 inches high, formed of six lenses subtending a vertical angle of 80°, with a radius of 250 mm. It gives, like its prototype, a double flash, each of 2½ minutes duration, divided by an eclipse of four minutes, with an interval between the groups of 21 minutes, the revolution being in 90 minutes. The carbons used were, like those at St. Catherine's, 60 mm. in diameter, of the excellent flute type of Sir J. Douglass. The power or intensity of the beam is not exactly known. It is, perhaps, forty times that of the first order oil light at its maximum. And yet this power of the Chelsea light is nothing as compared with that of La Hève. In favor of the French light are (1) size of optical apparatus; (2) lesser number of panels or greater horizontal angle of panels; (3) speed of rotation; while on the English side the only advantage is in the size of the carbons and intensity of the current.

The principle of rapid rotation is, of course, not new. The archetype of the whirled-round burning stick is very old. In Alan Stevenson's monumental work on lighthouses, dated 1850, occur some interesting pages on Captain Basil Hall's proposal to increase by rapid rotation the luminous effect of fixed lights, and, although no practical adoption was then found expedient, the experiments of Mr. Stevenson developed some memorable facts bearing on ocular sensibility, and on the effect of motion on the volume and intensity of light. Lord Kelvin, in his paper read at the Naval and Marine Exhibition, Glasgow, 11th February, 1881, observes with his usual precision: "From physiological experiments already made, it has been concluded that $\frac{1}{15}$ of a second is a long enough time to fully excite the sensibility and perceptive power of the eye, and it seems probable that rapidity of recurrence of the contrasts between light and darkness will give a positive advantage to the quicker flash in respect to perceptibility, even when the observer knows in what direction to look; and when he does not know exactly in what direction to look, which is the practical case of a sailor at sea trying to pick up a light, shortness of the time of invisibility is of supreme importance."

There is another development of the application of electricity to small dioptric lights which I have for many years advocated, but which has failed to find general acceptance as yet. I allude to ship signal lights. I have pointed out on many occasions, and last year at the International Maritime Congress in London, the immense disadvantage of ordinary side lights, owing to the absorption—and the very unequal absorption—of the rays from the oil lamp by the coloring media of red and green. And I have shown how easy and how beneficial it would be to employ true dioptric lenses and electric glow lamps in the focus of these lenses, of such proportioned power as would render a steamer's three signals of equal intensity, and therefore equal visibility at all distances. Is it not to be hoped that this simple measure, so likely to lessen the risks of collision, and to promote the safety, and even the speed of our vessels, will soon obtain general adoption?

[Official Notice.]

September Meeting, Society of Gas Lighting.

Society of Gas Lighting, Office of the Secretary,
Brooklyn, September 6, 1894.

The September meeting of the Society of Gas Lighting will be held at the Arena, 31st street and Broadway, at 3 P.M., Thursday, 13th inst.

Fred. S. Benson, Secretary.

ITEMS OF INTEREST FROM VARIOUS LOCALITIES.

Dinner to Mr. A. C. Humphreys.—A very enjoyable time was experienced by those who attended the dinner tendered to Mr. A. C. Humphreys by Capt. W. H. White, at the Lotos Club, on the evening of the 5th inst. The spread was the result of the genial host's desire to wish a safe voyage and speedy return to the city of Mr. Humphreys, who sailed for London, last Saturday, on the record-breaking Lucania. Among those who cheered the guest and saluted the host were Messrs. W. H. Bradley, Fred. S. Benson, Thos. E. Byrne, C. J. R. Humphreys, W. W. Randolph, Chas. A. Bennett and J. F. Edey.

We regret to report the death of the Hon. Jas. P. Ray, an honored and useful member of the Board of Directors of the Woonsocket (R. I.) Gas Company. At a special meeting of the Board the following action was taken respecting his demise:

Whereas, The Board of Directors of the Woonsocket Gas Company has learned with deep regret and sadness of the death of its recent associate, Mr. James P. Ray, and

Whereas, His long and honorable service as a Director in the above Company has always been marked by universal courtesy, active participation in the affairs of the Company, and conspicuous ability in its internal management; therefore, be it

Resolved, That this Board extends to his bereaved family its heartfelt sympathy and condolence in this its hour of trial; and be it further

Resolved, That a copy of these resolutions be spread upon the record book of this Company, and also that a copy be sent to the members of his family.

THE Elizabeth (N. J.) Gas Company is putting down the pipe which is to connect that works with the Rahway plant, the purchase of which latter by Mr. Kean was reported some time ago in the JOURNAL. The piping scheme also includes a gas supply for Linden, which place is about midway of Elizabeth and Rahway. In all, about 15 miles of mains have been arranged for.

MR. C. T. FROST, who for 18 years acceptably filled the position of Superintendent to the Rockland and Thomaston (Me.) Gas Light Company, resigned that berth to accept a similar position with the Summit (N. J.) Gas Light Company.

AN explosion of gas that took place in the cellar of the United States bonded warehouse, in Vallejo street, near Front street, San Francisco, Cal., on December 1st, 1891, caused the death of James J. Wallace, a laborer employed in the warehouse. On August 23d, his widow, on behalf of herself and her three children, began an action to recover damages for the loss sustained by her and them, the case to be tried in the Supreme Court. It is alleged that the San Francisco Gas Light Company, against which corporation the suit is brought, is responsible for defendant's death, because of its negligence to keep its pipes in good repair. Plaintiff puts the total damages at $55,000—$25,000 on personal account, and $10,000 for each of the children.

THE Larchmont Electric Company, of Mamaroneck, N. Y., has placed the contract for its power station with the Berlin Iron Bridge Company, of East Berlin, Conn. The same contractor will also construct three large buildings for the Union Metallic Cartridge Company, of Bridgeport, Conn.

THE following notice was recently issued to the people of Bradford, Pa., by the proprietors of the Commercial Natural Gas Company of that place: "It is shown to be impossible to get all the meters applied for placed by September first, in pursuance of the notice issued by this Company, that no gas would be sold after September first except through registering meters, and said notice is hereby modified as follows: All consumers who make application for meters to be set previous to September first will be charged the old rate until the Company can set the meters in their houses and places of business. After September first and until October first, all parties not having applied for meters to be set will be charged $2 per month for cook stoves, $1.25 per month for each heating stove or grate, and 15 cents for each tip per month, excepting such parties as have time contracts still in force. The rate by registering meter will take effect at the beginning of the month following the setting of the meter, and it will be 23 cents per 1,000, with 3 cents per 1,000 discount, if paid before the 10th of each month."

THE Bly Gas Burner Company has been incorporated at Sioux City, Iowa, by Messrs. M. M. Gray, B. F. Bly and O. C. Servis. The object of the Company is the manufacture and sale of the Bly patent gas burner for cooking and heating. Sioux City is to be the headquarters of the Company.

AT a special election at St. Charles, Mo., the voters indorsed the franchise recently granted to Messrs. Williams & McGee, authorizing the latter to construct and operate an electric lighting plant.

THE Brookline (Mass.) Gas Company has leased for a term of five years the second story of the building, 152 Tremont street, Boston, formerly occupied by the Messrs. Chickering & Sons.

ANOTHER effort will be made to pass an ordinance in Philadelphia City Council appropriating a sum of money sufficient to enable Chief Park to put the municipal gas plant in something like modern shape. We understand the output of gas is increasing rapidly in Philadelphia, the residents having at last begun to appreciate the fact that dollar gas is cheap.

MR. ABRAHAM L. DITMAS, Secretary of the Flatbush (L. I.) Gas Company, died at his home in Flatbush, on Monday, September 3d. He was in his 64th year, and had lived in Flatbush all his life, where he was universally esteemed.

SOME time ago we reported the death of Colonel J. B. Sanborn, who for years had been active in the management of the Concord (N. H.) Gas Company, and since that notice appeared the following action over his demise was taken at a special meeting of the Directors of the Company: "The Directors of the Concord Gas Light Company are moved to say how deeply they regret the death of Colonel Josiah B. Sanborn, long and honorably connected with the Company and recently its President. His bold, manly ways of thinking and stout-hearted ways of doing were exceedingly helpful; but if he was a good Director, so was he a good citizen and a faithful friend. In such relations each member of the Board knew him, and each will hold him in kindly, respectful remembrance."

THE repairs on the generating plant of the Pittsfield (Mass.) Gas Light Company have been completed, and the supply of the town is again giving complete satisfaction.

WILLIAM VAN SCIVER has taken legal steps against Thomas Knowles and the Georgetown (D. C.) Gas Light Company to have an old conveyance of lots 187 to 189, in Beall's addition to Georgetown, made by William F. Dixon to James Wardell, on June 15, 1855, set aside and the property transferred to him. He says that he had information from Sarah V. Williams early last June that this deed was fraudulently made and executed. William Van Sciver, the former proprietor, who is now deceased, being an illiterate man, unable to read and write. He also asks that a deed of trust executed to the Georgetown Gas Light Company, October 9, 1876, be declared by the Court null and void.

THE following clipping, from Fresno, Cal., was forwarded by a San Francisco correspondent: "The incandescent light system of Fresno has been shut down because the decline in the business of the local Company has been so great that it was constantly losing money. Superintendent Decker, when spoken to on the matter, said: 'At the time of our shutting down we were running 400 incandescent lamps, whereas a year ago we were running 900, so you can see how great the failling off in our business has been.'"

A BOGUS gas collector has been going the rounds of the consumers who patronize the Fulton Municipal Gas Company, which does not say much for the astuteness of the consumers. He succeeded in collecting some money, and his method of quieting the suspicion of those whom he called upon was to inform them that "the regular collector of the Company was on his vacation."

IN accordance with the order of Judge Windes, the Companies composing the Chicago Gas Trust have elected the following named Boards of Directors and executive managements: *Chicago Gas Light and Coke Company*—Directors, E. J. Jerzmanowski, C. K. Wooster, W. J. Campbell, J. R. Custer, J. A. Griffin, J. M. Cameron, G. W. Whitfield, F. A. Crane and Robert Donaldson; President, E. J. Jerzmanowski; Vice-President and Treasurer, C. K. Wooster; Assistant Secretary and Treasurer, Robert Donaldson. The *Consumers Gas Company*—Directors, E. C. Benedict, L. A. Wiley, J. R. Morris, F. H. Benedict, John Mackay, George Hunt, C. S. Clark, T. E. Rees; President, E. C. Benedict; Vice-President, L. A. Wiley; Secretary and Treasurer, R. J. Morris. *Equitable Gas Light and Coke Company*—Directors, F. S. Hastings, J. M. Miller and H. S. Morgan; President, F. S. Hastings; Vice-President, J. M. Miller; Secretary and Treasurer, H. S. Morgan. *Peoples Gas Light Company*—Directors, C. K. G. Billings, E. J. Jerzmanowski, F. S. Winston, G. O. Knapp, J. S. Zimmerman and W. F. Stewart; President, C. K. G. Billings; Secretary and Treasurer, G. O. Knapp. *Suburban Gas Company*—Directors, Casimir Tag, F. M. Blount, E. J. H. Wright, A. E. Stevens and Robert Ford; President, Casimir Tag; Vice-President, F. M. Blount; Secretary and Treasurer, E. J. H. Wright. *Lake Gas Company*—Directors, A. N. Brady, J. H. Chichester, Richard Rees, C. P. Cushman and W. S. Dole; President, A. N. Brady; Vice-President, J. H. Chichester; Secretary, Richard Rees. We have no report of the officers chosen by the Hyde Park Gas Company.

THE order also declared that each Company in the agreement should maintain separate offices, and the locations of the same are as follows: Chicago Gas Light and Coke Company, Michigan avenue and Madison street; Consumers Gas Company, No 26 Adams street; Equitable Gas Company, 69 Dearborn street; People's Gas Light and Coke Company, 39 South Halstead street; Suburban Gas Company, No. 1741 North Clark street; Lake Gas Company, 63d and Yale streets; Hyde Park Gas Company, 4232 College Grove avenue; Lake Gas Company, 63d street and Stewart avenue.

MESSRS. HENNESSY AND TWAMLEY have acquired a controlling interest in the Economical Gas Company, of Grand Forks, North Dakota.

ON September 1st the Hyde Park Gas Company, one of the companies formerly represented in what was known as the Chicago Gas Trust,

and which supplies gas in the Chicago district south of 39th street and east of State street, reduced its selling rates to conform with those of the Hyde Park Mutual Fuel Gas Company, which also operates in the above-mentioned territory. The new prices are: For illuminating purposes, $1 per 1,000; for fuel purposes, 72 cents per 1,000.

In our issue for May 21, 1894 (p. 727), we published an interesting statement by Mr. F. H. Mason, U. S. Consul at Frankfort, Germany, on "Progress in Gas Motors for Street Railways," and supplementary thereto we give the following later mention of the subject by the same authority: "In a former report some account was given of a street railway car of the Lührig model, propelled by a gas engine and carrying its supply of compressed gas in cylindrical reservoirs hung beneath the floor of the vehicle. Although of recent invention and somewhat complicated in construction, this car had been worked successfully in Dresden at a net cost of operation so far below that of electric or even horse railways that it seemed to embody the germ at least of a new and important departure in street railroad equipment, particularly for the large class of lines whereon traffic is limited and varies essentially in volume at different seasons or hours of the day. Through the death of the inventor and other circumstances, the ardor of improvement appears to have been temporarily checked in Germany, and the field of experiment has been transferred to England, where the Lührig patents have been acquired by a syndicate, and the car has undergone, during the past four or five months, modifications which, from trustworthy accounts, have greatly lessened its weight and cost and enhanced its practical value.

"A car of this improved type is now worked regularly on the lines of a tramway company at Croydon, near London, and has attracted expert attention from all parts of Great Britain, where the problem of street railway equipment and management is quite as complicated and difficult as in any portion of the United States. Not less than $70,000,000 is invested in tramway lines within the United Kingdom, with results so generally unsatisfactory, as regards profits to stockholders, that there is a wide and urgent demand for a new and simplified motor or system that will secure equal effectiveness and greater economy in operation. Notwithstanding the relative dense population of great Britain, only a small proportion of its tramways as worked at present by cables, steam locomotives, electricity, or horse power are really satisfactory to the public or pay regular dividends. The same need exists there, as elsewhere, for a motor which shall be clean, noiseless, manageable, independent of overhead wires or underground constructions, and, withal, so cheap in initial investment and working expense as to successfully supersede horse cars, to which there are many objections on the score of cleanliness, speed and economy on lines which have a light or varying volume of traffic.

"One important difficulty in the case of every self-contained car lies in the fact that, for climbing grades, starting under full load, passing curves, or meeting sudden falls of snow, a car which, when in motion, can be easily drawn by two horses must be equipped with a motor capable of exerting temporarily 10 or 12 horse power, and for this a considerable weight of machinery is unavoidable. The general defect which has been found in gas motors for street railway purposes hitherto has been that they have been available only for light traffic, and, if made sufficiently powerful for city lines, their excessive weight and cost would form a fatal objection.

"Through the modifications which have been made in the Lührig motor car by the English engineers, these defects are believed to have been practically overcome. The original car was rigged with two double-cylindered gas engines, one under each seat, and both working upon the same driving shaft, and weighed, without passengers, 7½ tons. In the improved car but one gas engine is used, the two cylinders of which are set facing each other and both working to the same crank. The engine is located under the seat on one side of the car; the other end of the driving shaft, which extends across beneath the floor of the vehicle, carrying a fly-wheel, which steadies and regulates the motion of the engine. By this improvement, the number of working parts, and, therefore, the weight, cost, and wear and tear of the motor have been greatly reduced. What is equally important, in a commercial sense, the motor has been reduced to a form and dimensions which will permit it to be adjusted to cars already built for cable, electricity, or horse power.

"But, by reducing the engines to one, the power of the car to start promptly with a heavy load was compromised, and this weakness has been overcome by the momentum of the fly-wheel and by the device of keeping the engine constantly in motion while the car is in service and transmitting its power from the crank-shaft, through a second-motion shaft, to the running gear by friction clutches under control of the driver. This is arranged as follows:

"The driver, standing on the front platform, has before him the brake wheel and beside him a movable lever not unlike the reversing bar of a locomotive. When this lever is in a vertical position, the engine shaft is disconnected from the second-motion shaft and the axles, so that the car may be at rest while the engine is running free. When the lever is pushed to the right, the second-motion shaft, with which the axles are connected by chain gearing, is brought into engagement by a pinion and friction clutch, which gives the car a speed of 4 miles per hour. Shoving the lever to the left brings into engagement a similar pinion, which, without changing the speed of the engine, gives the car a pace of 8 miles an hour, which is the limit of speed allowed by the municipality of Croydon. A second lever is provided for operating reversing clutches whenever, at the end of the line or elsewhere, the movement of the car has to be reversed. The friction clutches, which form so important a feature of the machine, are made of hard wood set between the two discs of iron, and are said to be effective and durable.

"There must be, of course, some device to regulate the speed of the engine and keep it as nearly as possible uniform while the car is stopped and under the varying conditions of grade and load. This has been provided for with great ingenuity—first, by a governor, which, when the work is light, cuts off automatically the gas supply from one of the cylinders, leaving the other to do the work alone, and, still further, through a mechanical connection between the governor itself and the lever, already described, which operates the clutches. When this lever is upright and the engine shaft disengaged from the axle gearing a weight on the spindle of the governor is lifted, which cuts off the gas at half stroke in the one working cylinder, so that, while the engine is running free with the car at rest, it is reduced to half speed, and the explosions are rendered so light and gentle as to be hardly perceptible.

"Ordinary street gas is used, condensed to a pressure of 10 atmospheres, and the reservoirs under the floor of the car—which can be filled through a flexible pipe within the time required to change horses—carry gas enough for a run of 8 or 10 miles. The consumption of gas by a loaded car is stated to be 25 cubic feet per mile, which costs, at Croydon, 2 cents. The syndicate under whose management the car now in service has been built and tested is naturally disinclined, as yet, to disclose fully the detailed results; but the editor of *Engineering*, who has been permitted to examine the experiments somewhat carefully, states his conclusions as follows:

"'The car is not noticeably different from a horse car. It runs quietly and easily, emitting neither smoke nor steam, and is quite under control. Inside passengers can hear a slight rumble of machinery and perceive a trifling vibration; but, after a minute or two, these are unheeded, and, practically, there is nothing to detract from their comfort. Neither they nor the bystanders in the street can perceive any machinery whatever, for the engine and gearing are entirely inclosed, the motor lying under one seat and the wheels and clutches under the floor of the car. * * * It carries 28 passengers in all and makes a very fair speed, the limit allowed by the Board of Trade being 8 miles per hour. With the slow gear in action, it will readily mount an incline of 1 in 23, with a short piece of 1 in 16, and in coming down, it can be stopped by the brakes in its own length. It also goes round a curve of 35 feet radius on a 1 in 27 grade. Its weight, when filled with passengers, is 5½ tons. For gas, it costs 1d. (2 cents) per mile, against 3½d. (7 cents) per mile for fodder and bedding for horses; so that the gas motor car starts with an advantage of 2½d. (5 cents) per mile. The performance of the car is quite satisfactory.'

"The main question, which remains to be decided by prolonged experience, would seem to be that of net cost of maintenance. The initial cost of the motor car is about the same as that of an ordinary horse car, and the eleven horses which are required on well-managed lines to operate it. The point to be determined is, whether it is or is not cheaper to keep one gas engine in order than to keep in health and serviceable condition eleven horses, and whether the machine will last longer in service than the animals. When the motor car is not needed, it costs nothing but a shed to shelter it, while the horses must be fed and cared for. From the English standpoint, the horse car is the only system that offers any serious competition with gas, and, as the latter starts with an advantage of 5 cents per mile in the cost of material consumed, its victory on a large majority of lines in that country would seem to be more than probable.

"A special motor car of the type above described, combining all the improvements thus far made and reduced to the utmost limit of simplicity and lightness, is now being constructed in England, to be carried to the United States for exhibition and trial in October. Its performances will doubtless merit the attention of all who are interested in the complicated subject of city and suburban transportation."

THE AMERICAN GAS LIGHT JOURNAL

A. M. CALLENDER & CO.,
PROPRIETORS.

EDITOR—Jos. R. Thomas, C.E.
ASST. EDITOR—T. J. Cunningham.
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MONDAY, SEPTEMBER 10, 1894.

An Odd Experience Gained by a Plumbing Inspector.

A plumbing inspector notes that a curious, and for the time being puzzling, incident came before the notice of the plumbing inspectors of New York city not long ago. It appears that in a certain eight-story business building down town, the drinking water above the third story gave forth an odor as if of illuminating gas and it also possessed a gassy taste, if illuminating gas can possess a taste. The water which was supplied to the building from a tank located on the roof filled every day by a Worthington steam pump situated in the cellar had, up to this time, been pure and clear as Croton water can be.

The part that puzzled the clerks and business men of the building was that below the third floor the water did not seem at all contaminated by any gaseous smell or taste. The New York city health board was notified and several inspectors were sent to investigate.

It was finally resolved to dig out to the water main in the street, after an examination had shown the tank on the roof in good condition, and that no gas pipes ran near it.

So laborers were set to work digging, and in front of the building they discovered, upon a mighty close inspection only, that the main lead service pipe had become pitted by the action of the sandy soil.

Another close investigation brought to light a short distance away an odor as of illuminating gas, and it was further found that a gas main near by was in a leaky condition.

The Worthington pump in the cellar was set in operation and the inspectors awaited developments. Every time the pump drew in water through the lead main, it was observed that a slight film which usually forms on the inside of lead service pipe drew itself inward, and with the holding of the water until the motion of the pump the following second the pressure forced the film back without permitting the escape of any water.

It was figured out and the problem solved in this way: Sandy soil will pit lead pipe; it had done so in this instance; nearby was the leaky gas main. Inside the building in the cellar was the steam pump which sucked in through pitted service pipe the escaping gas, carrying it up to roof into the tank, and as the tank only was necessary to supply to the fourth floor, the city pressure being sufficient for the floors below, the reason why the odor and taste of illuminating gas in the drinking water above third floor, and the clearness of the water below, was evident. The gas main was repaired, new lead service replaced the old, and now the Worthington pumps Croton uncontaminated for those who desire to use it.

The Market for Gas Securities.

The market for city gas shares was dull and restricted for the week, the changes having been nominal rather than real. Consolidated was a shade easier, although it was freely bid for this morning (Friday) at 123, holders refusing to accept less than 123½. Other city shares are dull and strong, Equitable being bid for at 175, and Mutual is wanted at 150. A small lot of Mutual sold this week at auction at the current bid price.

The Addicks and Rogers factions in Brooklyn have combined forces, which leaves the Nassau and Williamsburgh Companies in the position of independents. As near as one may judge from surface indications, the ultimate result will be the purchase by the Rogers-Addicks syndicate of the Nassau and Williamsburgh holdings, in which event either Nassau or Williamsburgh shares ought to be good investments at the quoted rates. Chicago gas is rather uncertain these days, and it is barely possible that the cut in rates in the Hyde Park district may lead to a royal row there. Meanwhile we would advise investors and speculators, too, for that matter, to wait before doing anything in Chicago. Baltimore Consolidated is strong at 67¼ to 67⅜, and Bay State common reflects in its strength the light recently shed on the Addicks-Rogers deal in Brooklyn. We understand that another dividend development will shortly appear in connection with Consumers' of Jersey City.

Gas Stocks.

Quotations by Geo. W. Close, Broker and Dealer in Gas Stocks.

16 WALL ST., NEW YORK CITY.

SEPTEMBER 10.

☞ All communications will receive particular attention.
☞ The following quotations are based on the par value of $100 per share.

	Capital.	Par.	Bid	Asked
Consolidated	$35,430,000	100	123	123½
Central	500,000	50	103	—
" Scrip	220,000	—	100	—
Equitable	4,000,000	100	165	—
" Bonds	1,000,000	—	106	108
Metropolitan, Bonds	658,000	—	108	112
Mutual	3,500,000	100	145	—
" Bonds	1,500,000	—	100	102
Municipal, Bonds	750,000		—	—
Northern		50	80	95
" Bonds	150,000	—	—	100
Richmond Co., S. I.	348,650	50	50	—
" Bonds	100,000	—	—	—
Standard Gas Co—				
Common Stock	5,000,000	100	25	30
Preferred	5,000,000	100	80	—
Yonkers		50	112	—
Gas Co's of Brooklyn.				
Brooklyn	2,000,000	25	101	103
Citizens	1,200,000	20	—	—
" S. F. Bonds	320,000	1000	—	101
Equity Gas Light Co	2,000,000	100	—	—
Bonds	1,000,000	—	—	—
Fulton Municipal	3,000,000	100	128	—
" Bonds	300,000		103	—
Peoples	1,000,000	10	65	70
" Bonds (7's)	368,000	—	100	—
" " (6's)	94,000	—	98	100
Metropolitan	870,000	100	137	—
" Bonds (5's)	70,000	—	—	155
Nassau	1,000,000	25	150	—
" Ctfs	700,000	1000	99	100
Williamsburgh	1,000,000	50	138	—
" Bonds	1,000,000	—	107	110
Out of Town Gas Companies.				
Bay State Gas Co.—				
Stock	5,000,000	50	21	21¼
Income Bonds	2,000,000	1000	60	—
Boston United Gas Co.—				
1st Series S.F. Trust	7,000,000	1000	80	83
2d " " "	3,000,000	1000	59	—
Buffalo Mutual, N. Y.	750,000	100	120	—
" Bonds	200,000	1000	95	100
Citizens, Newark	1,000,000	50	160	—
Chicago Gas Company.	25,000,000	100	74¼	74⅜
Chicago Gas Light & Coke Co.—				
G't'd Gold Bonds	7,650,000	1000	81⅛	81½
Consumers Gas Light Co., Jersey City	2,000,000	100	56	60
Bonds	600,000	1000	92	—
Cincinnati G. & C. Co.	7,000,000	100	192	—
Consumers Toronto	1,600,000	50	184½	187
Central, S. F., Cal			90	100
Capital, Sacramento, Cal			—	55
Consolidated, Balt.	11,000,000	100	67¼	67¾
" Bonds	6,400,000		107	107½
Citizens Gas Lt. Co., Rochester, N. Y.	500,000	—	85	101
Bonds	250,000		—	—
Detroit Gas Co.—				
Con. Bonds			—	50
East River Gas Co., Long Island City	1,000,000	100	16	19
Preferred			25	35
Bonds	500,000	100	80	82
Equitable Gas & Fuel Co., Chicago, Bonds	2,000,000	1000	—	101
Hartford, Conn	750,000	25	120	128
Jersey City	750,000	20	190	200
Louisville, Ky	2,570,000	50	125	130
Laclede Gas Light Co. St. Louis, Mo.—				
Common Stock	7,500,000	100	19	19½
Preferred "	2,500,000	100	72	74
Bonds	9,034,400	1000	88	—
Little Falls N. Y.	50,000	100	—	100
" Bonds	25,000	—	100	103
Montreal, Canada	2,000,000	100	200	208
New Haven, Conn		25	200	—
Oakland, Cal			42⅝	43
People's Gas and Coke Co., Chicago—				
1st Mortgage	2,100,000	1000	—	108
2d "	2,500,000	1000	104	105
Peoples, Jersey City	500,000	—	175	185
" " Bonds			—	—
Paterson, N. J		25	99	102
Rochester, N. Y		50	80	85
Preferred			90	95
Bonds			90	95
Syracuse, N. Y	500,000	25	—	—
San Francisco Gas Co. San Francisco, Cal	10,000,000	100	71	71½
Washington, D. C	2,000,000	20	240	—
Wilmington, Del	500,000	50	188	190

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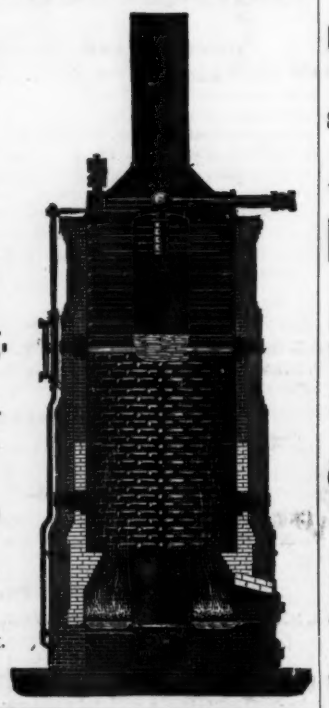

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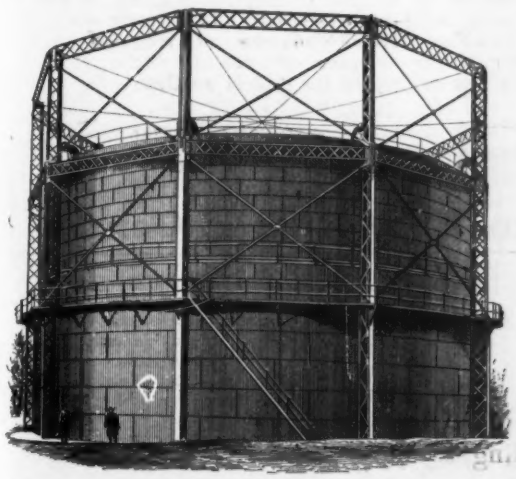

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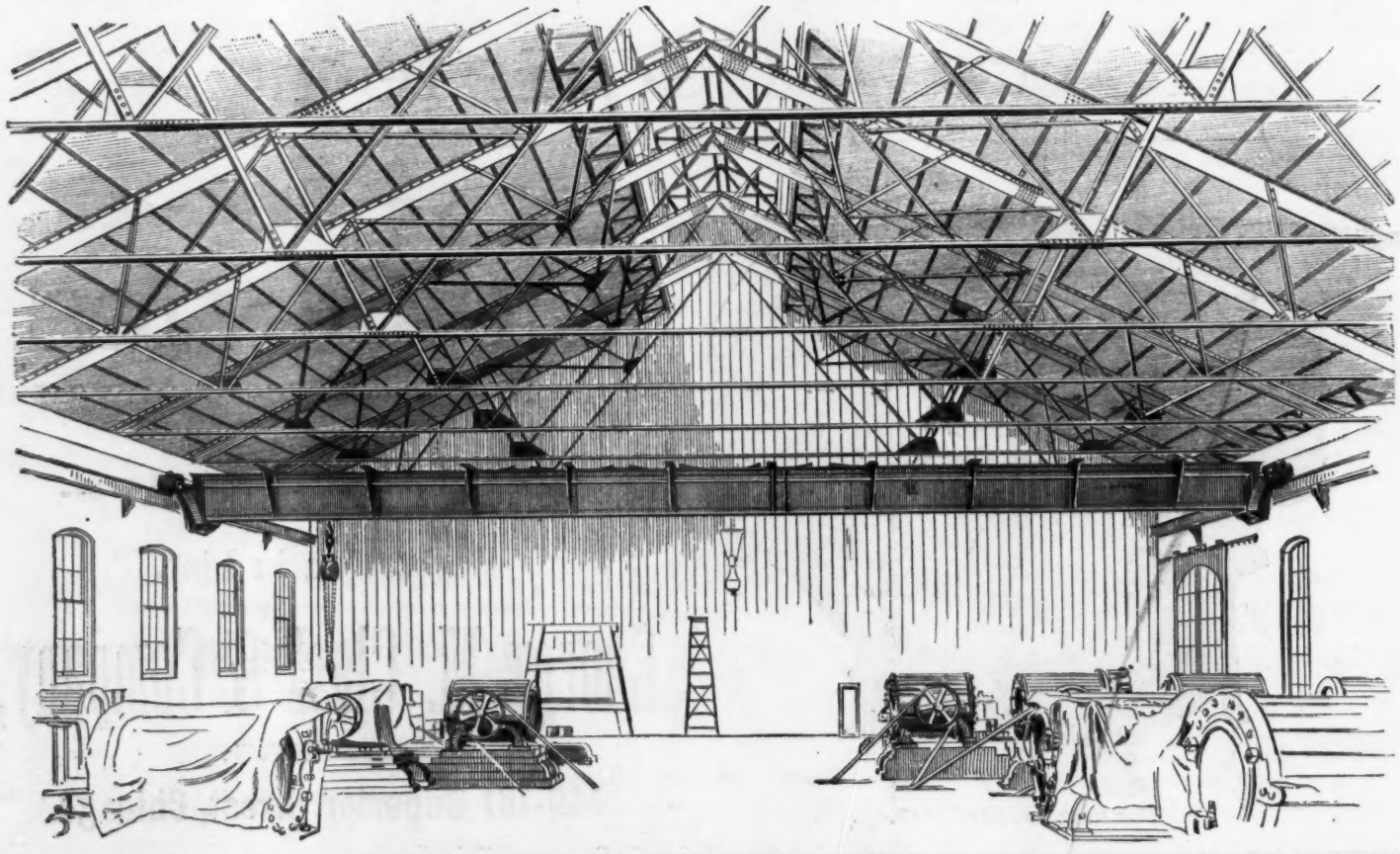

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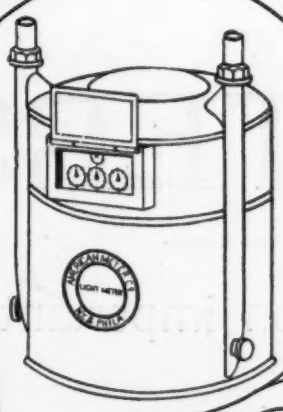

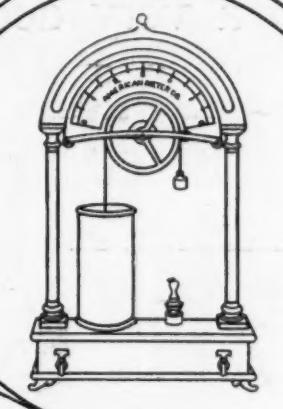

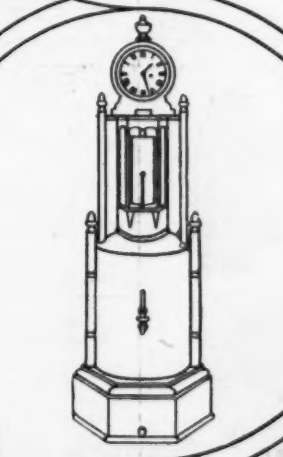

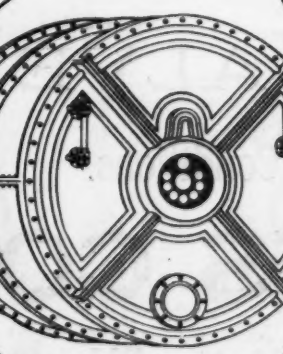

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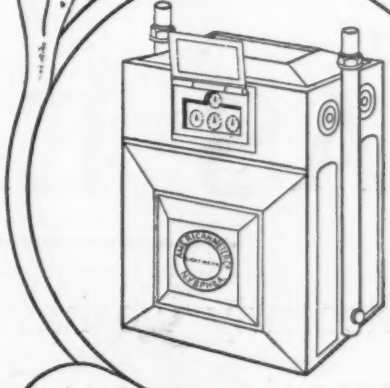
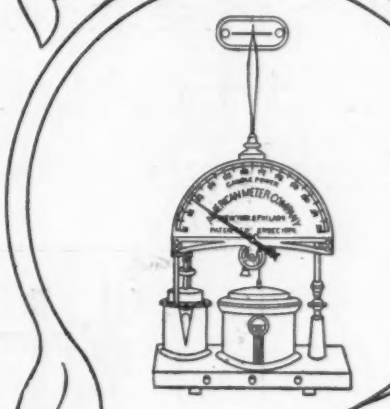
SEPTEMBER, 1894.

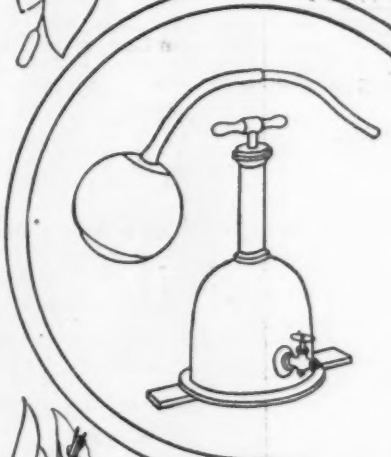
Day of Week.	Date.	Table No. 1. Following the Moon. Light.	Extingnish.	Table No. 2. New York City. All Night Lighting. Light.	Extinguish.
				P.M.	A.M.
Sat.	1	7.00 PM	4.30 AM	6.30	4.20
Sun.	2	7.00	4.30	6.30	4.20
Mon.	3	7.00	4.30	6.15	4.30
Tue.	4	7.50	4.30	6.15	4.30
Wed.	5	8.30	4.30	6.15	4.30
Thu.	6	9.10 FQ	4.30	6.15	4.30
Fri.	7	9.50	4.30	6.15	4.30
Sat.	8	10.50	4.30	6.15	4.30
Sun.	9	11.50	4.30	6.15	4.30
Mon.	10	12.50 AM	4.40	6.05	4.40
Tue.	11	1.50	4.40	6.05	4.40
Wed.	12	2.50	4.40	6.05	4.40
Thu.	13	No L.	No L.	6.05	4.40
Fri.	14	No L. FM	No L.	6.05	4.40
Sat.	15	No L.	No L.	6.05	4.40
Sun.	16	6.40 PM	7.50 PM	6.05	4.40
Mon.	17	6.40	8.10	5.55	4.50
Tue.	18	6.30	8.30	5.55	4.50
Wed.	19	6.30	9.10	5.55	4.50
Thu.	20	6.30	9.50	5.55	4.50
Fri.	21	6.30	10.40	5.55	4.50
Sat.	22	6.30 LQ	11.40	5.55	4.50
Sun.	23	6.30	12.50 AM	5.55	4.50
Mon.	24	6.20	2.10	5.40	5.00
Tue.	25	6.20	3.30	5.40	5.00
Wed.	26	6.20	4.50	5.40	5.00
Thu.	27	6.20	4.50	5.40	5.00
Fri.	28	6.20	4.50	5.40	5.00
Sat.	29	6.20 NM	4.50	5.40	5.00
Sun.	30	6.10	5.00	5.40	5.00

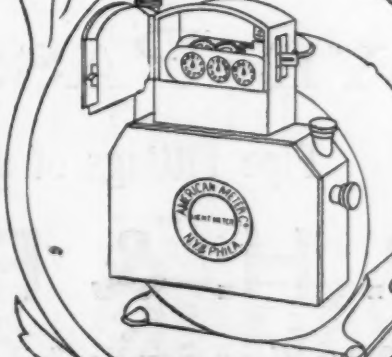
TOTAL HOURS LIGHTING DURING 1894.

By Table No. 1.	Hrs. Min.	By Table No. 2.	Hrs. Min.
January	244.10	January	423.20
February	195.30	February	355.25
March	206.20	March	355.35
April	169.40	April	298.50
May	162.10	May	264.50
June	135.40	June	234.25
July	146.30	July	243.45
August	162.20	August	280.25
September	174.10	September	321.15
October	211.20	October	374.30
November	221.00	November	401.40
December	245.30	December	433.45
Total	2274.20	Total	3987.45









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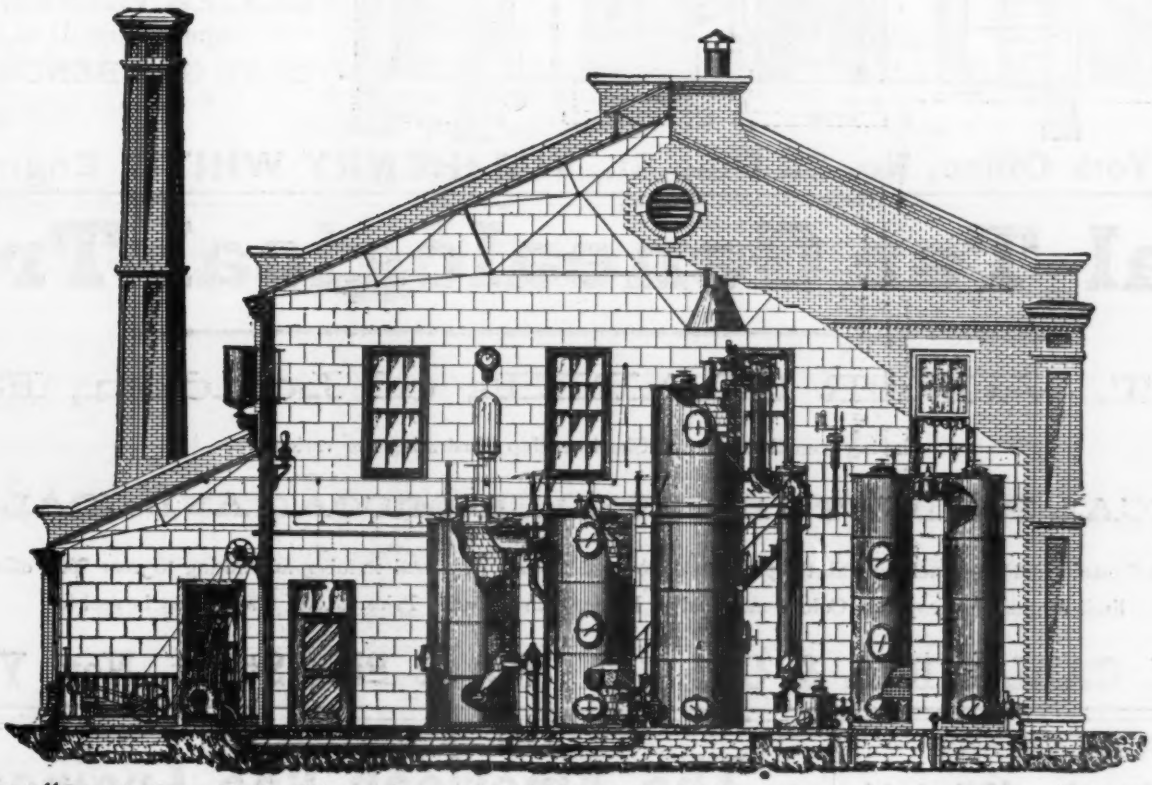

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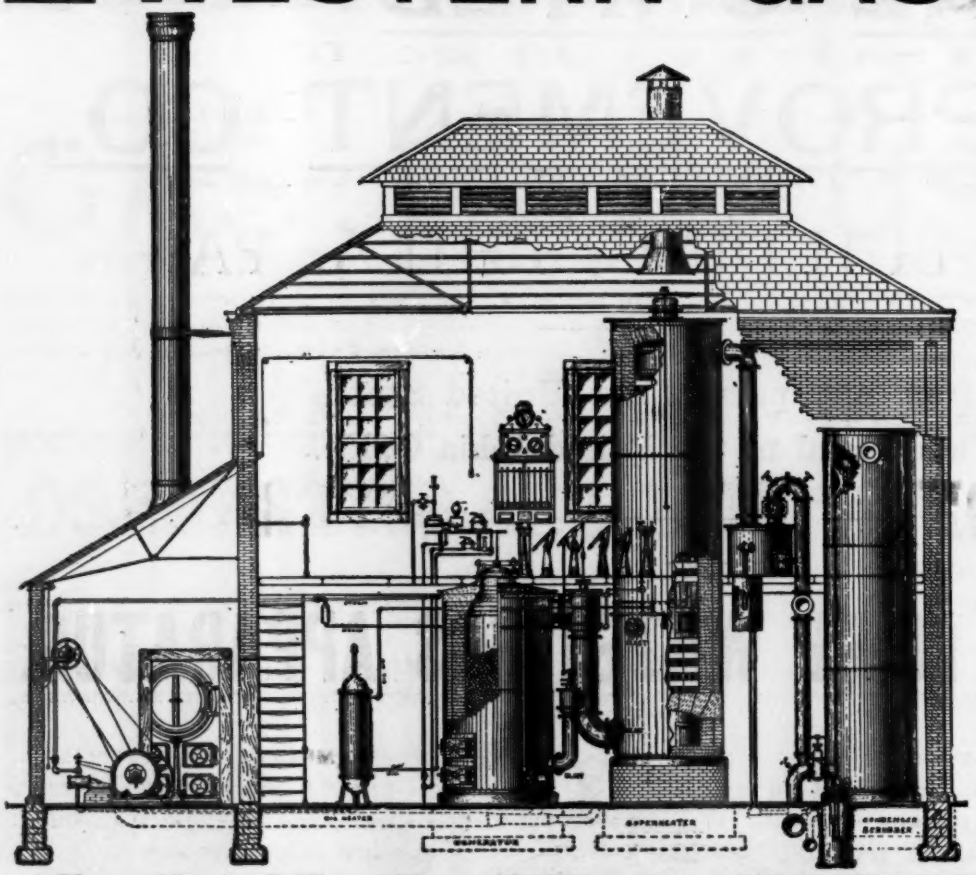

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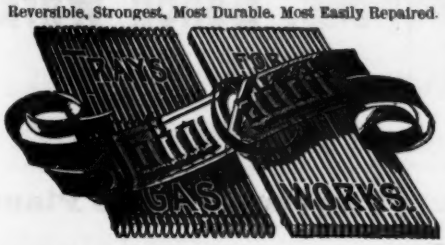

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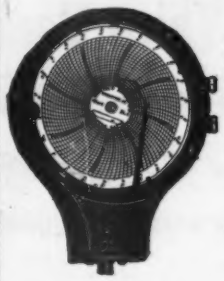

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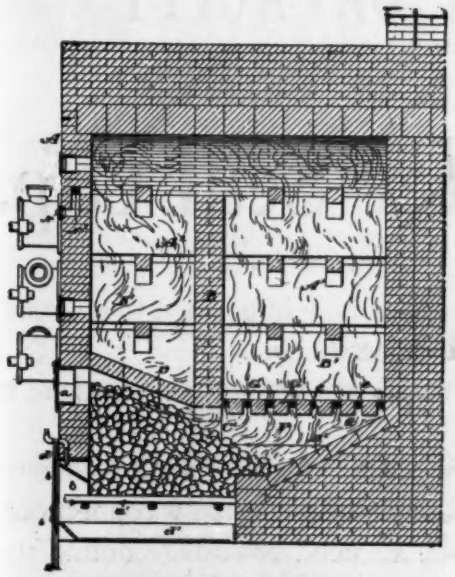

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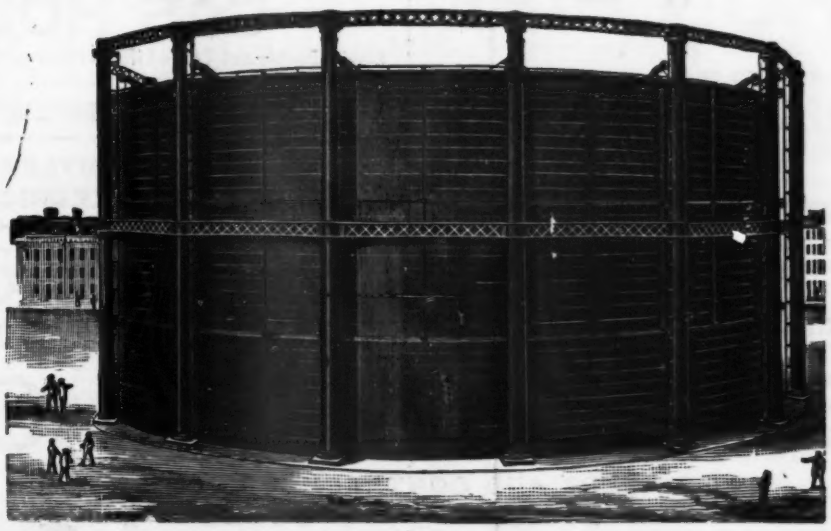

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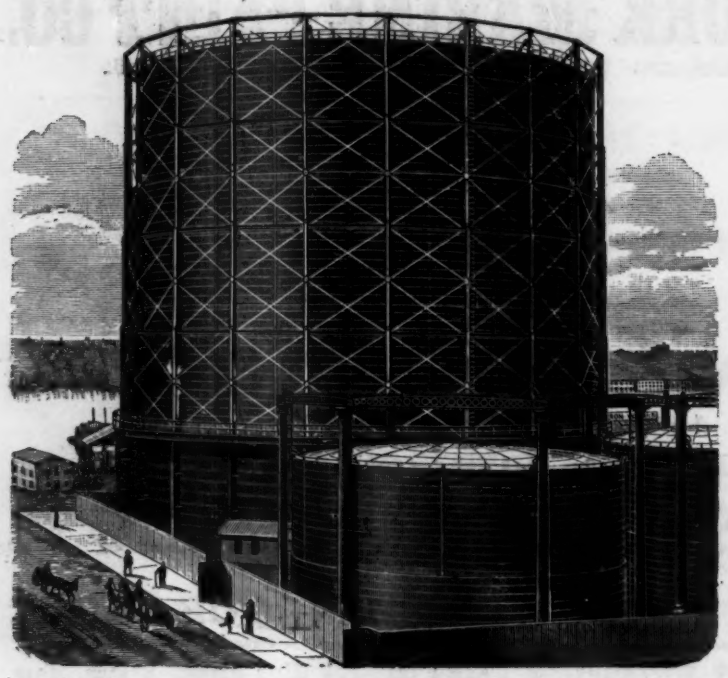

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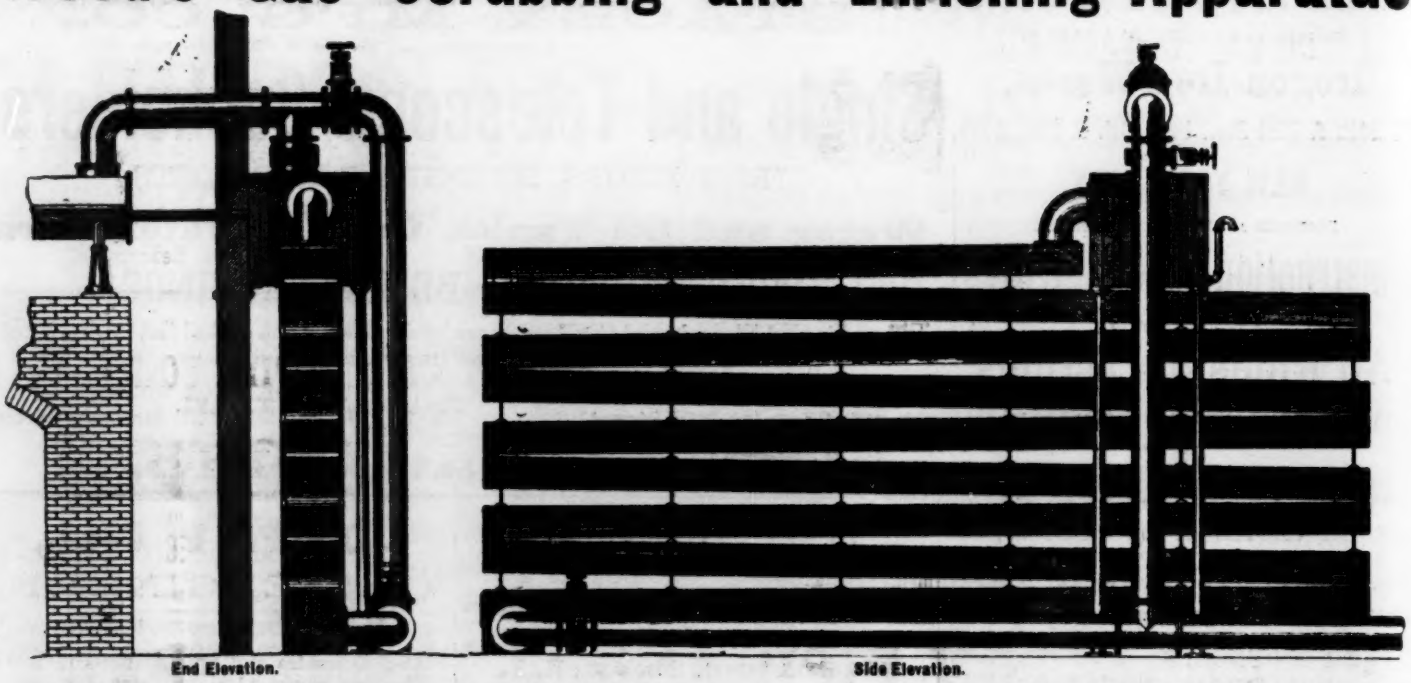

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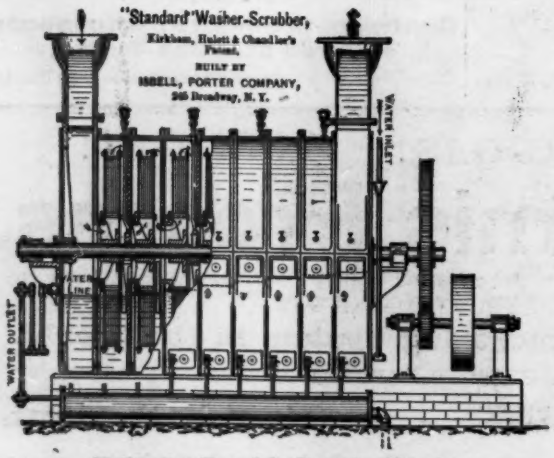

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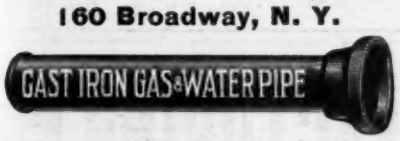

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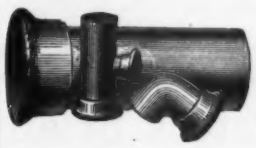

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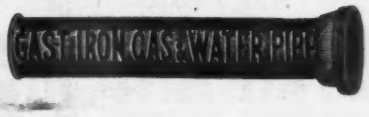

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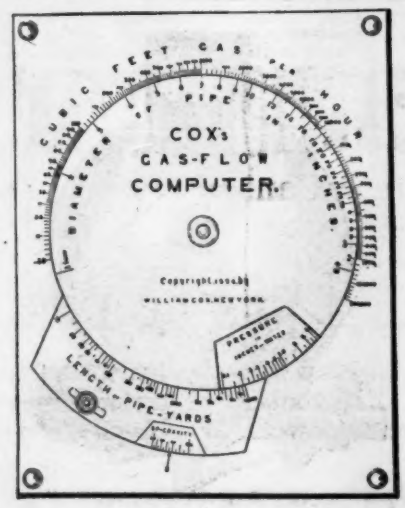

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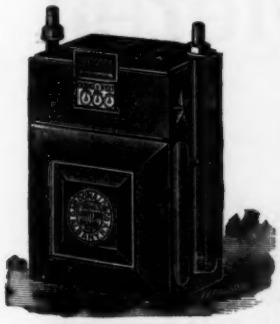

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